THE GLASS INDUSTRY
THE JOURNAL OF GLASS MANUFACTURING
VOLUME 42 NUMBER 11 NOVEMBER, 1961

Periodically* The Glass Industry *publishes a report on container glass compositions. The purpose of these reports is to show composition trends from 1932 on, and to define the ranges of chemical compositions and values for selected physical properties of glasses manufactured during the year immediately preceding publication. This year's review is based on statistics for production through 1960.

Container Glass Compositions 1932 to 1960

by R. E. Loesell and W. R. Lester,

Project engineer and chief glass technologist, respectively, Emhart Mfg. Co., Hartford Div., Hartford, Conn.

The following report includes data and measurements compiled every year since 1932. [1, 2, 3, 4, 5, 6] The individual tabulations are confidential, but there is a great amount of information in the form of summaries and charts that can be presented without revealing sources. While not all of the furnaces engaged in the melting of glass for containers are represented in the yearly summaries, the size and randomness of the samples appear adequate to assure a satisfactory representation of the glasses made by the glass container industry of the United States.

CONTAINER GLASSES—1932 TO 1960

Previous reports have presented the trends in composition on a yearly basis. To simplify presentation, the last report[6] disclosed trends by 5-year intervals from 1932 to 1957. In this report, the data for the year 1960 is compared with the 5-year and with other yearly data.

Major Oxides

As in previous reports, silica is considered alone, while alumina, calcia, magnesia, and barium oxide are grouped as stabilizing oxides, and alkali, boric oxide, sulfate, and fluorine are combined as fluxes. The average composition of glasses for 5-year intervals from 1932 to 1957 and for the year 1960 are presented in Table I and illustrated in Fig. 1. (See page 624.)

The average silica content has declined steadily from 74.1 per cent in 1932 to 71.7 per cent in 1960, a decrease of 2.4 percentage units. The average of the stabilizing oxides has increased steadily from 9.1 per cent in 1932 to 13.5 per cent in 1960, an increase of 4.4 percentage units. Prior to 1937, only about 10 per

cent of the container glasses were made with calcite limestone. By 1960 this percentage had increased to almost 65 per cent. This increase, in part, appears to have been brought about by expansion of the industry into areas where calcite is the lowest cost source for the RO group.

The alkali and minor constituents, grouped as fluxes, show a steady decrease from a value of 16.8 per cent in 1932 to 14.9 per cent in 1960, with the total decrease amounting to almost 2 per cent. During the first 5 years of the period 1932 to 1960, the changes in average composition were relatively small. From 1937 to 1947 the rate of change of each of the three groups was very rapid, with both silica and fluxes being replaced by stabilizing oxides.

The 1960 data show that, while the period 1947 to 1960 represents a marked slow-down of former trends with the silica apparently more or less stabilized at a value near 71.75 per cent, there now exists a trend for stabilizing oxides to replace alkali. Substitution of sabilizing oxides for silica or alkali results generally in glasses of higher potential productivity. The trend is in this direction.

TABLE I—Averages of Three Major Groupings—1932 to 1960

Year	SiO_2	Stabilizing Oxides	Fluxes
1932	74.1	9.1	16.8
1937	73.7	9.6	16.7
1942	72.8	11.3	16.0
1947	72.4	12.4	15.3
1952	72.1	12.5	15.5
1957	71.8	13.1	15.2
1960	71.7	13.5	14.9

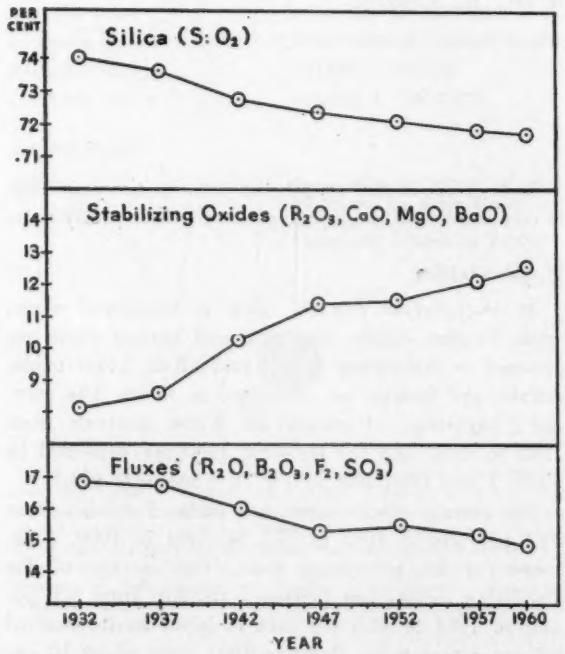


Fig. 1. Yearly average of grouped major constituents, 1932 to 1960.

Minor Constituents

The minor constituents such as alumina, barium oxide, boric oxide, sulfate, and fluorine are present in container glasses to impart desirable characteristics. Their use has been based on the results of research confirmed by practice. The averages of the minor constituents are presented in Table II and illustrated in Fig. 2. In all cases, the values shown are based on averages obtained from the total number of glasses in which the presence of the particular constituent was considered intentional rather than adventitious.

With the demand in 1939 for glasses of increased chemical durability, the average value for alumina increased from 1.3 per cent to a value close to 2.1 per cent. Alumina is also employed to modify the working characteristics of glasses and to prevent devitrification. Considering that the maximum resistance of glasses to chemical attack by water is obtained when the percentage of alumina is approximately one-eighth the percentage of alkali[8], it seems that alumina is being used to some excess in order to modify working characteristics or to make use of available raw materials. Part of the rise to 2.1 per cent can be attributed to the continued

TABLE II—Averages of Mirror Constituents—1932 to 1960
(Using Only Those Values Representing Intentional Additions)

Year	R_2O_3	BaO	B_2O_3	F_2	SO_3
1932	1.3	0.7	—	—	0.2
1937	1.3	0.5	0.6	0.2	0.2
1942	1.7	0.4	0.6	0.2	0.2
1947	1.9	0.3	0.2	0.2	0.2
1952	2.1	0.5	0.4	0.2	0.2
1957	1.9	0.5	0.2	0.2	0.2
1960	2.1	0.3	0.1	0.2	0.2

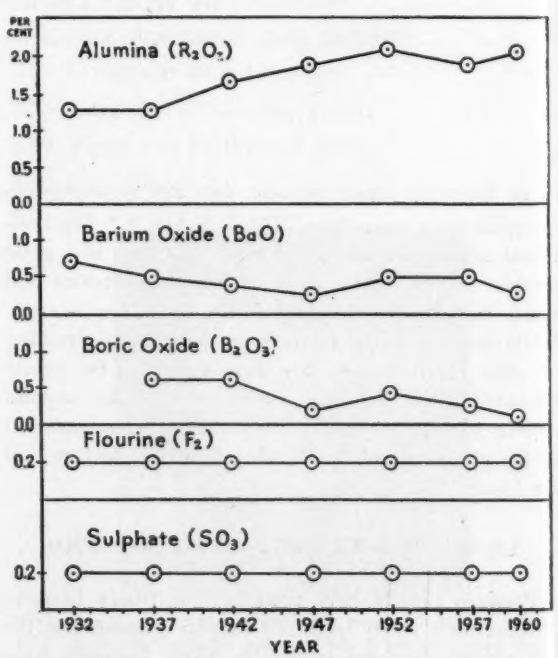


Fig. 2. Yearly average of minor constituents, 1932 to 1960.

use of local high-alumina sands by West Coast factories.

Barium oxide experienced a downward trend from its highest value of 0.7 per cent in 1932 to a low of 0.3 per cent in 1947. Between 1952 and 1957 the use of barium oxide stabilized at a value of 0.5 per cent. Since 1957 it has decreased again to a low of 0.3 per cent in 1960.

In 1934, the first year in which all glasses received for analyses by our laboratories were systematically checked for B_2O_3 content, it was found that of the glasses containing intentional additions of boric oxide, the average content was approximately 1 per cent. By 1937 this had dropped to 0.6 per cent, where it remained through 1942. By 1947 it had decreased further to 0.2 per cent, but 1952 saw an increase to 0.4 per cent. Boric oxide content decreased further to 0.2 per cent by 1957, and by 1960 reached a new low average of less than 0.1 per cent. In some cases additions of boric oxide are automatic by the fact of its presence in soda ash from brines.

Fluorine is one of the few minor constituents for which usage was first firmly established by laboratory measurements and tests, followed by successful large-scale production. Its average value has therefore been steadily maintained at about 0.2 per cent in those glasses containing more than trace amounts.

Sulfate has been found in all of the flint and green glasses and its average has been nearly constant at about 0.2 per cent. This percentage has also been fairly well established as the most effective proportion for effective fining, whether introduced as barytes, gypsum, or salt cake.

GLASSES—1960

The composition for container glasses manufactured in 1960 (Table III) represents the average composition of glasses from 76 different container furnaces. A survey shows that 58 per cent of the glasses analyzed were flint, 16.4 per cent amber, 15 per cent Georgia green, 7 per cent ulta-violet absorbing green, and 3.6 per cent emerald green.

Range of Compositions

The ranges of compositions used in 1960 are represented by distribution charts of the various constituents (Fig. 3 through 10).

Silica: The silica contents of glasses in 1960 (Fig. 3) ranged from 67.5 to 74.5 per cent. It should be noted that about 90 per cent of the glasses fell in the 70.5 to 73.5 per cent range.

Alumina: As in 1957, the largest proportion of glasses contained 1.5 to 2.0 per cent alumina (Fig. 4). The value of alumina for imparting improved chemical durability is indicated by the almost total lack of glasses having an alumina content below 1.5 per cent. Those glasses containing the largest percentages of alumina represent geographical locations where sand of high-alumina content is used.

TABLE III—Average Composition Container Glasses—1960
(Using Found Values)

	Per Cent	Total
Silica		
SiO_2	71.7	71.7
Stabilizing Oxides		
R_2O_3	2.05	
$CaO + MgO + BaO$	11.50	13.55
Fluxes		
$Na_2O + K_2O + B_2O_3$	14.50	
$SO_3 + F_2$	0.35	14.85
Flint Glasses		
Fe_2O_3	0.053	
Amber Glasses		
Fe_2O_3	0.205	
S	0.04	

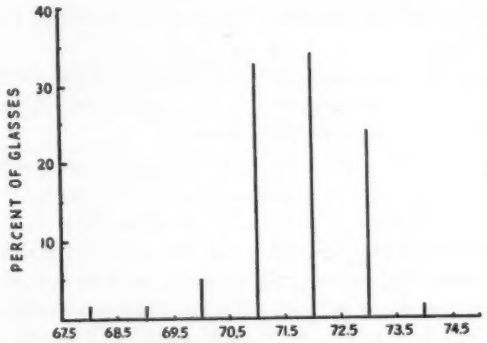


Fig. 3. Percentage of silica (SiO_2) in container glasses.

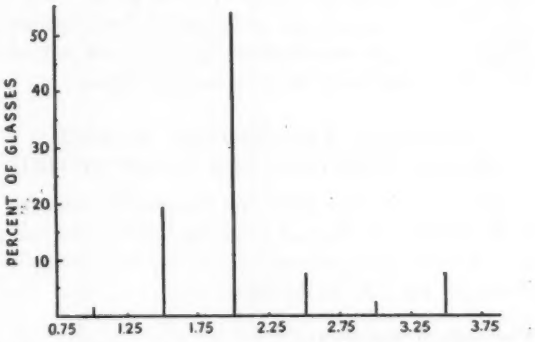


Fig. 4. Percentage of aluminum and iron oxides (R_2O_3) in container glasses.

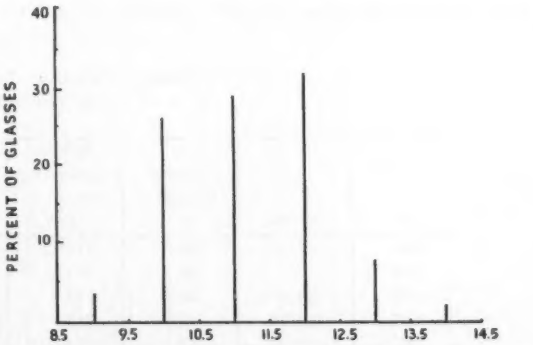


Fig. 5. Percentage of calcium and magnesium oxides ($CaO + MgO$) in container glasses.

Calcium and Magnesium Oxides: Approximately 85 per cent of 1960 glasses contained between 9.5 and 12.5 per cent calcia plus magnesia (Fig. 5). A shift has occurred since 1957, at which time the largest number of glasses contained only 10 per cent RO oxides. In 1960 the largest number of glasses were found in the 12 per cent class.

Sodium and Potassium Oxides: The total of these constituents (Fig. 6) ranged from 12.75 to 16.75 per cent, with the peak of the curve about 14.5 per cent. The range and maximum peak of the curve have changed only slightly since 1957.

Barium Oxide: The distribution of the percentages of barium oxide is shown in Fig. 7. About 65 per cent of the glasses analyzed contained barium as an intentional addition, *i.e.*, 0.1 per cent or more. Most of these contained about 0.4 per cent, while a few contained up to 1 per cent.

Sulfate: The percentage of sulfate in oxidized glasses such as flint and certain greens (Fig. 8) ranged from 0.125 to 0.375, the average being 0.22 per cent.

Fluorine: About 95 per cent of the glasses analyzed in 1960 contained intentional additions of fluorine, 0.05 per cent or more (Fig. 9). The amounts found in these analyses ranged up to nearly 0.5 per cent, with the average being 0.21 per cent. Fluorine is used mainly as an aid to the fining of glasses having a moderate alumina content. It acts also to replace alkali in lowering viscosity, and therefore, working temperatures.

Boric oxide: About 80 per cent of the glasses (Fig. 10) contained no intentional additions of boric oxide, although some glasses contained B_2O_3 in small proportion from soda ash produced from natural brines.

PHYSICAL PROPERTIES, WORKING CHARACTERISTICS, AND GLASS QUALITY

All of the glasses in the 1960 survey were subjected to measurements of physical properties and to the calculation of working characteristics. The averages are given in Table IV and Fig. 11 through 18.

Physical Properties

Density: The density of the glasses, gm/cc at 20°C, is shown in Fig. 11. The values ranged from 2.472 to 2.522, with the average value at 2.500. Density is scarcely a significant property, although glasses of low density may be associated with excessive surface cords on the ware produced.

Thermal Expansion: The average coefficient of thermal expansion (0 to 300°C) showed a spread of 81 to 95 by 10^{-7}/°C, with the peak at 87 by 10^{-7}/°C (Fig. 12).

Softness Temperature, Annealing Point, and Strain Point: The values for these three low-temperature viscosity points are shown in Fig. 13 through 15. A comparison of these values with those of other years is given in Table V. In 1954, the log viscosity values for the annealing point and strain point were redefined by H. R. Lillie.[9] All of the values determined prior to 1954 have been corrected for these changes. The average value of *softness temperature* in 1960 was 715° with a range from 700°C to 730°C. The *annealing point* average was 539°C with a range from 520°C to 565°C. The *strain point* averaged 497°C with a range from 470°C to 525°C.

TABLE IV—Averages of Values of Physical Properties of Container Glasses Manufactured in 1960

Physical Properties	
Density g/cc at 20°C	2.5000
Softness Temperature (log viscosity = 7.65)	715°C
Annealing Point (log viscosity = 13.0)	539°C
Strain Point (log viscosity = 14.5)	497°C
Average Coefficient of Thermal Expansion by 10^{-7} (0 to 300°C)	87.9
Working Characteristics	
Relative Gob Temperature (log viscosity = 3.0)	1207°C
Working Range Index	176
Relative Machine Speed	105
Glass Quality	
Homogeneity Grade	B
Seeds and Blisters per Ounce	40
Blisters per Ounce	4

Working Characteristics

Formulas reported by A. K. Lyle[7] have been used successfully for determining the working characteristics of glasses from low-temperature viscosity data. These formulas are used in calculating working range index, relative machine speed, and relative gob temperature.

Working Range Index: This is the numerical difference between the softness temperature and the annealing point. Thus it represents the temperature rate of change of

TABLE V—Working Characteristics and Physical Properties for Various Years from 1948 to 1960*

Year	Density	Thermal Expansion X 10^{-7}/°C	Softness Temperature log η = 7.65	Annealing Temperature log η = 13.0	Strain Temperature log η = 14.5	Gob Temperature log η = 3.0	Working Range Index	Relative Machine Speed
1948	—	89.3	710°C	528°C	483°C	1220°C	182	100
1949	—	90	712	534	490	1210	178	103
1950	2.4910	88.9	712	535	491	1208	177	103
1957	2.4998	88.9	714	536	496	1212	178	104
1960	2.5000	87.9	715	539	497	1207	176	105

*Log viscosity of the annealing and strain points were changed in 1956, and the values obtained prior to 1957 have been adjusted to these new figures.

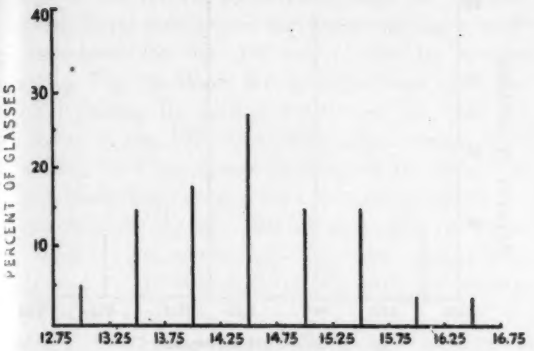


Fig. 6. Percentage of sodium and potassium oxides ($Na_2O + K_2O$) in container glasses.

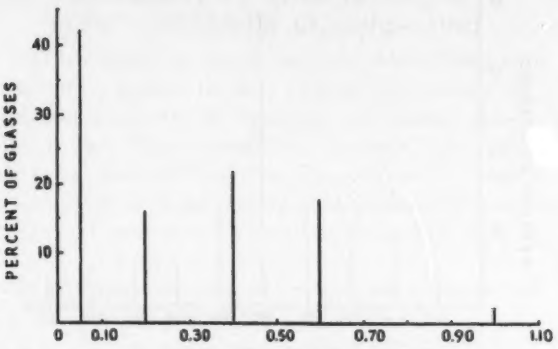


Fig. 7. Percentage of barium oxide (BaO) in container glasses.

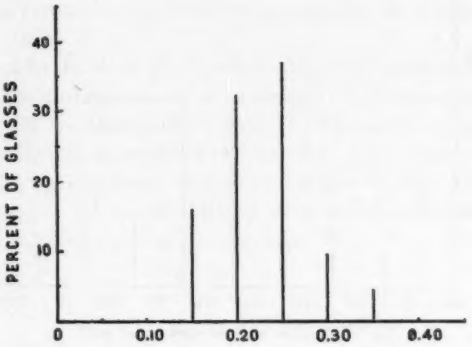


Fig. 8. Percentage of sulfate (SO_3) in container glasses.

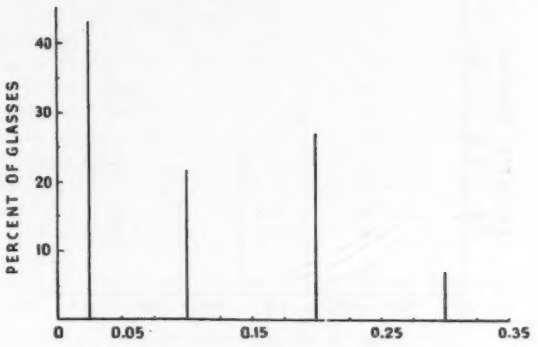


Fig. 9. Percentage of flourine (F_2) in container glasses.

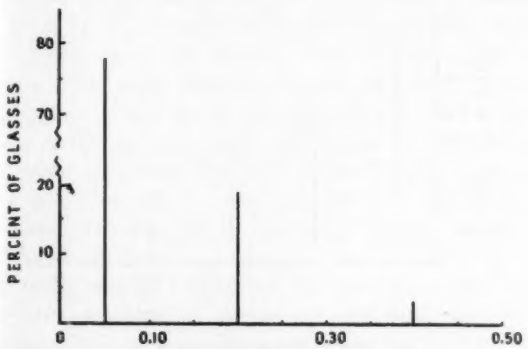


Fig. 10. Percentage of boric oxide (B_2O_3) in container glasses.

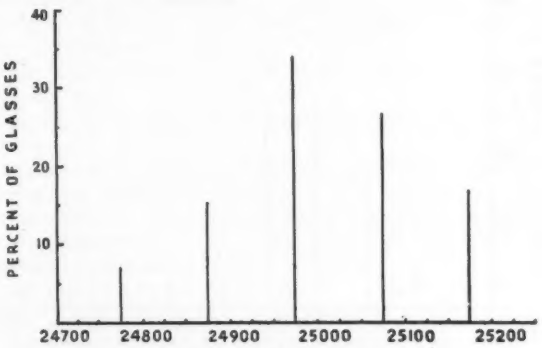


Fig. 11. Density (g/cc at 20°C).

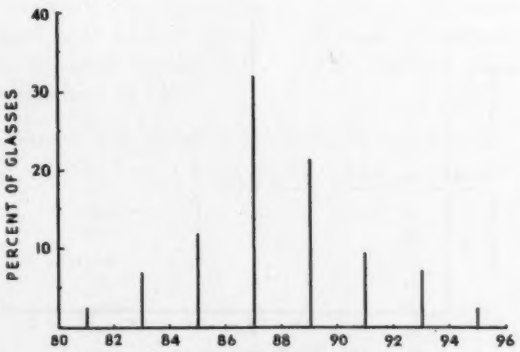


Fig. 12. Thermal expansion (by 10^{-7}).

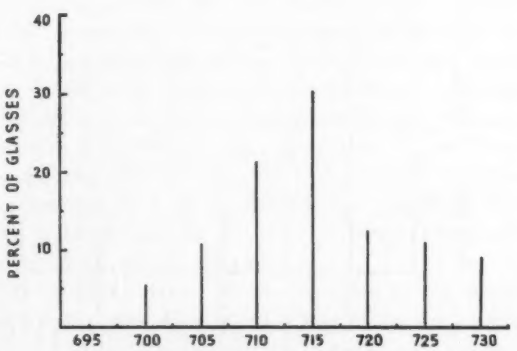


Fig. 13. Softness temperature (degrees C).

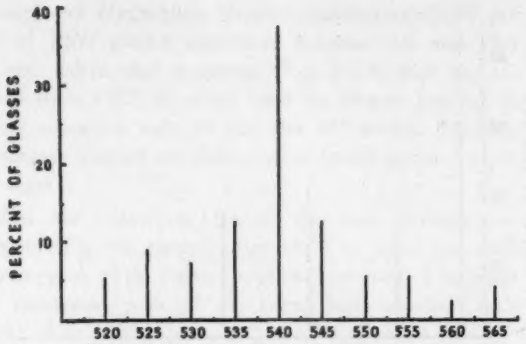


Fig. 14. Annealing point (degrees C).

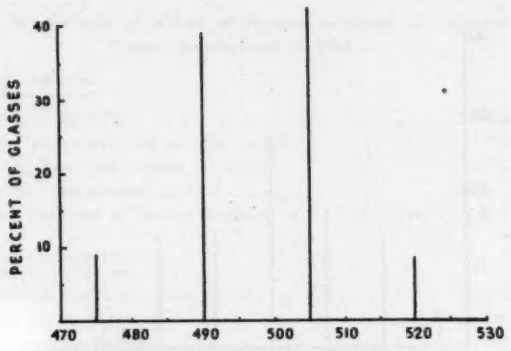


Fig. 15. Strain point (degrees C).

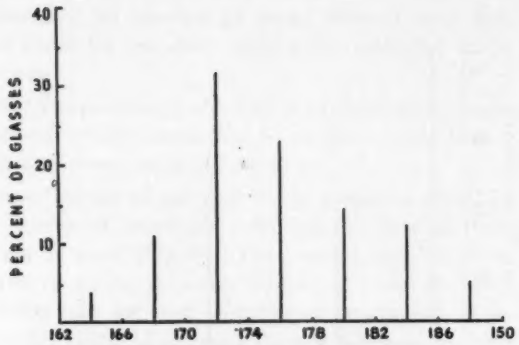


Fig. 16. Working range index.

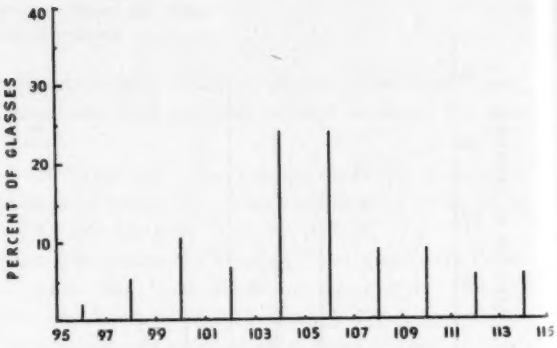


Fig. 17. Relative machine speed (per cent).

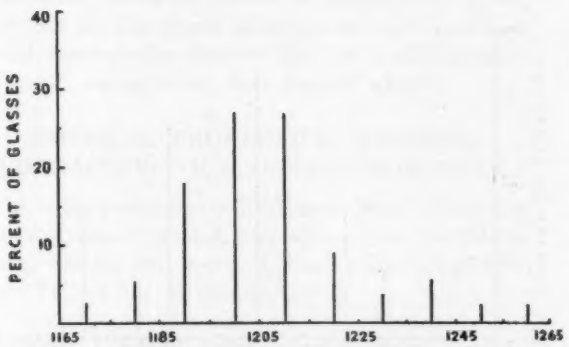


Fig. 18. Relative gob temperature (degrees C).

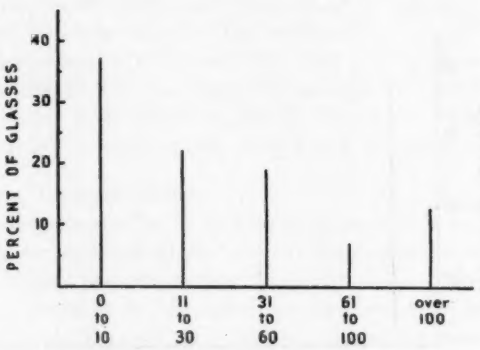


Fig. 19. Homogeneity grade.

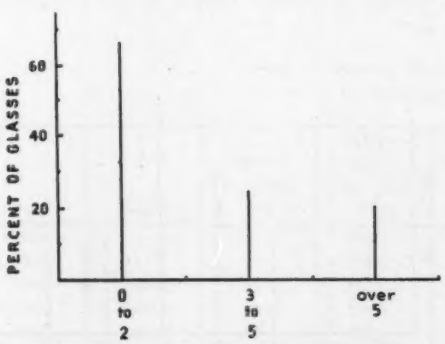


Fig. 20. Seeds and blisters per ounce.

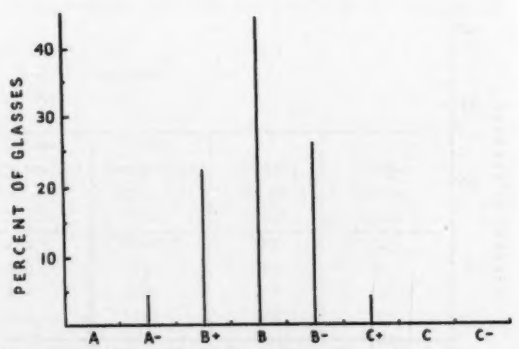


Fig. 21. Blisters per ounce.

viscosity or the relative temperature range for working of a glass. It has been shown that glasses having a working range index less than 163 tend to devitrify in some operations. Fig. 16 shows the working range index for the 1960 glasses. Its average value was 176, with the peak being at the 172 value. The values ranged from 164 to 188. Very few glasses approached the value 163, at which devitrification becomes a potential problem.

Relative Machine Speed: This characteristic, as calculated from low-temperature viscosity data, ranged from 95 per cent to 115 per cent with the peak and average being 105 per cent (Fig. 17).

Calculated Gob Temperature: With log viscosity at 3.0, this value ranged from 1170°C to 1260°C (2138°F to 2300°F), with the peak value being near 1210°C (2210°F). The higher temperatures represent, in general, glasses containing appreciable proportions of magnesia (Fig. 18).

In order to show the trend of the working characteristics, the averages for several selected years between 1948 and 1960 are also listed in Table V. During this period, the temperature equivalents for the low-temperature viscosity points have undergone radical changes, and, in terms of calculated working characteristics, have resulted in lowering of gob temperature by 13°C, a marked lowering of the working range index by six units, and an increase of 5 per cent in the relative machine speed,

Glass Quality

Ratings of glass quality are shown in Fig. 19 through 21. A summary of these values for several years is shown in Table VI. *Homogeneity* has remained at the B average for approximately the last ten years. *Seediness values* have a wide range, from none to several hundred seeds per ounce. Those above 100 are marked 100+. The large percentage of glasses with values of more than 100 seeds per ounce has displaced the average level of seediness from 30 per ounce in 1957 to 40 in 1960. Actually, more than 50 per cent of the glasses show seed counts of less than 25 per ounce.

Blisters, which by definition are relatively large bubbles, are considered as originating from some secondary reaction between the melting glass and the furnace atmosphere or the refractories. A blister count of more than 5 per ounce usually indicates abnormal conditions somewhere in the nose of the furnace or in the feeders. From Fig. 21 it can be seen that abnormal blister conditions appeared in only a few of the container glasses manufactured in 1960.

TABLE VI—Glass Quality (Average Values for Various Years)

Year	Homogeneity	Seeds per Ounce
1946	B	20
1947	B–	30
1948	B–	25
1949	B	25
1950	B–	30
1957	B	30
1960	B	40

GEOGRAPHICAL COMPARISON OF FLINT CONTAINER GLASSES—1960

The flint container glasses surveyed during 1960 were sufficient in number to allow comparisons between geographical areas. For this purpose, the United States is divided into three areas, the Northeast, the South-Southwest, and the West Coast. The averages of chemical compositions and the averages of physical properties for each of these areas are given in Tables VII and VIII.

TABLE VII—Geographical Comparison of Flint Container Glasses—1960
(Average Chemical Composition)

	Average Percentages		
	Northeast	South and Southwest	West Coast
Silica (SiO_2)	71.9	72.1	71.5
Iron + Aluminum Oxides (R_2O_3)	1.7	1.9	2.1
Calcia (CaO)	8.0	10.1	11.3
Magnesia (MgO)	3.5	0.5	0.1
Barium Oxide (BaO)	0.4	0.4	0.1
Sodium Oxide (Na_2O)	13.8	14.3	13.8
Potassium Oxide (K_2O)	0.3	0.4	0.9
Boric Oxide (B_2O_3)	—	—	0.15
Sulfate (SO_3)	0.22	0.24	0.20
Fluorine (F_2)	0.17	0.10	—
Iron Oxide (Fe_2O_3)	0.052	0.052	0.054

TABLE VIII—Geographical Comparison of Flint Container Glasses—1960
(Average Values of Physical Properties)

	Northeast	South and Southwest	West Coast
Density g/cc at 20°C	2.495	2.498	2.505
Coefficient of Thermal Expansion 0-300°C, X 10^{-7}/°C	86.3	89.0	90.2
Softness Temperature (log viscosity = 7.65)	714°C	713°C	720°C
Annealing Point (log viscosity = 13.0)	535°C	538°C	551°C
Strain Point (log viscosity = 14.5)	492°C	497°C	511°C
Relative Gob Temperature (log viscosity = 3.0)	1218°C	1203°C	1193°C
Working Range Index	179	175	169
Relative Machine Speed (per cent)	103	104	110

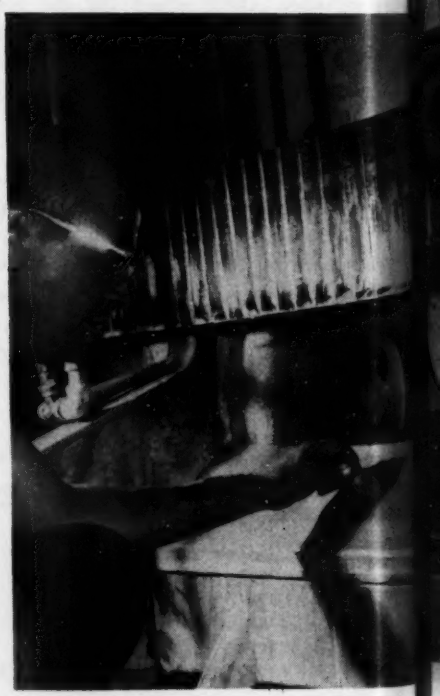
Chemically, several interesting differences are present. They are accounted for by the location of raw materials within economical shipping distances of the glass factory. A comparison of the ratio of magnesia (MgO) to calcia (CaO) shows that, in the Northeast, dolomite is the chief source of the RO group. In the South and Southwest, calcite is the chief source. On the West Coast, little or no dolomite is used. A comparison of the 1960 averages with the 1957[6] averages shows that, in the Northeast the total RO has increased from a value of 11.6 to 11.9 per cent, and on the West Coast, it has increased from a value of 10.6 to 11.5 per cent. The South-Southwest showed no change.

The higher average alumina content of the glasses made in the West Coast area is due to the use of feld-

(*Continued on page 661*)

Diamond Grinding to Mirror

For grinding pencil edges on two sides of a mirror, a machine (above, left) having three contoured diamond wheels on either side is used. An alkaline-base coolant, with rust inhibitor, is added during grinding. Speed is about 10 ft. per minute. The rubber cleats of one continuous belt conveyor (below) can be seen above the diamond wheels. The mirrors, clamped between two of these belts, pass over the beveling wheels (right) to the edging wheels (left). The beveling wheels are set at a slight angle to the mirror plane, while the lower edging wheel is set parallel to it.



Since 1948, when diamond grinding wheels and automated grinding machines first became available to the flat glass and mirror industries, remarkable progress has been made in increasing grinding efficiency. Within the mirror industry, the development of machines equipped with diamond wheels for beveling and edging plate glass has been hailed as the "biggest single technological breakthrough in the past half-century."*

Willard Mirror Co. of Fort Smith, Ark., installed its first diamond grinding machines for beveling and edging glass late in 1948. This producer of mirrors for the retail trade and furniture manufacturers is currently using three Sommer & Mecca automatic machines to bevel, edge, and polish millions of inches of high-quality glass each year. Mirrors that are to be edged only are finished on a Sun Tool automatic edger. Abrasive belts (30 to 40 of the silicon carbide type per day for edging in 1948) had previously been used; for edging extremely thin glass, the company now buys less than 100 of these abrasive belts a year.

In Willard's operation, six metal-bond diamond wheels in each of the three automatic machines grind the glass passing through them. The grinding surfaces of the wheels are impregnated with selected sizes of natural diamond particles, ranging in size from 60-mesh for rough grinding down to 600-mesh for the polish operation. Cerium oxide wheels put the final finish on the bevel. In addition to the diamond wheels in the auto-

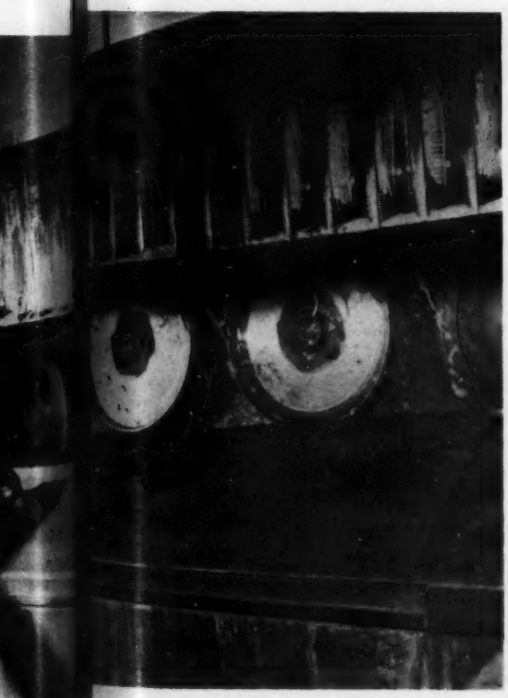
*W. D. Williams, vice-president, Willard Mirror Co.

Wheels—Boon Industry

An operator removes the guard from the edge-grinder, revealing the contoured faces of the pencil-edging wheels. Parallel edges are finished as the mirror is conveyed through the machine.

matic machines, two diamond wheels in a manually-operated grinder are used for touching up adges and edging mirrors the edges of which are not straight.

Hollow diamond drills, ¼ in. in diameter, are used in a high-speed drill press for boring holes in mirrors. An automatic edger is used for grinding "pencil" edges on plate glass at the rate of about 10 ft. per minute. In this machine, the contoured-face diamond wheels are positioned horizontally, three on each side of the machine's conveyor system. As the glass moves through the machine, two parralel mirror edges are ground to a satin finish. Distance between the two sets of wheels can be varied to grind mirror edges up to 72 in. in width.



The six diamond wheels on the automatic machines include four beveling wheels, a pencil-edging wheel, and a polishing wheel. A straight, uniform, highly-polished bevel is achieved by graduating the size of the diamond grit in the beveling wheels. The glass is rough-ground by a 60-mesh wheel, followed by an 80-mesh, a 150-mesh, and a 220-mesh wheel. The pencil-edging wheel, contoured to grind a rounded edge on the glass, contains 180-mesh natural diamond particles. The polishing wheel contains 600-mesh diamond grit.

Speed of travel of the mirrors through the beveling and edging machines depends upon the width of the bevel. A ½-in. wide bevel can be ground at the rate of about 42 lineal in. per minute; a 1-in. wide bevel is ground at about 18 lineal in. per minute. The diamond wheels, as well as the cerium oxide and felt wheels, are mounted vertically. The glass rests on edge as it is moved through the ginding operations by rubber-coated cleats that clamp the glass and hold it steady.

Performance life of the wheels depends to some extent on the size of the diamond grit and the type of grinding it is doing. Longest performance life is obtained from the finer-mesh beveling wheels which are now averaging about 4,500,000 lineal in. per wheel. According to Willard, the installation of diamond grinding operations has increased speed of production, improved quality of beveling and edging, and reduced scrap. The reduction of scrap (chipped or scratched mirrors) is attributable to less handling of the glass on the automatic machines, and to an absence of loose abrasives with diamond grinding.

With all of these achievements to their credit, diamond grinding wheels are being looked to by the mirror and flat glass industries for new developments to still further improve fabrication.

DIMENSIONAL ANALYSIS

Its Application to Models of Glass Tanks and Other Units

by Charles H. Greene,

Department of glass technology, College of Ceramics, Alfred University, Alfred, N. Y.

The use of models to study the behavior of glass in tanks and forehearths is desirable because of the high cost of experiments in full-sized units and because of the difficulty in observing just what happens at the high temperatures of actual operation. This is particularly the case when working out new designs. Although much useful work can be done with full-scale models employing viscous oil to represent glass, it is more convenient and economical to construct working models of the larger units on a reduced scale. It is the purpose of this paper to apply to the design of such models the principles of dimensional analysis. At the expense of some apparent complications, the treatment will be made as general and inclusive as possible.

By dimensional analysis, the following relationships, which, if the flows are to be similar, must exist between the variables involved in the flow of glass in a full-sized unit and the corresponding variables for a scale model, are deduced. The subscript m refers to the model.

$k = s^{3/2}$
$P_m/P = s^{5/2}$ the ratio of volumetric pulls.
$R_m/R = s^{-1/2}$ the ratio of stirrer rpm.
$V_m/V = s^{1/2}$ the ratio of fluid velocities at corresponding points.
$T_m/T = s^{1/2}$ the ratio of times where
$L_m/L = s$ the scale factor.
$(N_m/D_m) \;/\; (N/D) = k$ the ratio of kinematic viscosities.
N = viscosity
D = density

When the flow is slow and any rotational speeds are very low so that inertia of the glass may be neglected, both the scale factor s and the kinematic viscosity ratio k may be chosen at will. The other variables are related as follows.

$P_m/P = s^4/k$
$R_m/R = s/k$
$V_m/V = s^2/k$
$T_m/T = k/s$

When viscosity and density differences arising from temperature inequalities are significant, it is shown that "similar" gradients for both density and viscosity must be set up in the model if the flow is to be "similar." This may be done for one of these variables by suitable adjustment of the temperature at various points in the model. However, both density and viscosity gradients can be made similar in a model and full-sized unit only by finding a model fluid with the necessary particular relationship between thermal expansion and temperature coefficient of viscosity.

The general problem to be solved is the determination of the velocity of glass flow at an arbitrarily specified point in a glass manufacturing unit of specified dimensions. All of the dimensions, including the location of the specified point, may be given in the form of dimensionless ratios of the lengths in question to some principal dimensions of the unit, *e.g.*, its length L which is given in physical units such as feet. If this problem is solved in general for the glass velocity at any desired point, all details of the glass flow will be known. Since velocity is a vector, the determination of velocity at a specified point involves the actual determination of the components of velocity in three orthogonal directions, *i.e.*, solving three problems rather than one at each specified point. As far as dimensional analysis is concerned, however, the problems are all of the same nature.

In addition to the linear dimensions of the unit, the glass flow will, in general, depend also on the force of gravity and on the following variables: *(1)* density of the glass at all points, *(2)* viscosity of the glass at all points, *(3)* rate of pull, *(4)* rate of rotation of stirrers or sleeves, *(5)* velocities of needles, etc., and *(6)* time. We shall assume that the size of the unit is great enough so that the glass flow is not appreciably affected by surface tension. Velocities encountered in tanks, forehearths, and feeders are, of course, far below those

at which the compressibility of the fluid has any influence on the flow. Temperature has no influence except through its effect upon density and viscosity.

For certain problems, useful results can be obtained after making the simplifying assumption that the temperature of the glass is constant throughout the unit so that viscosity and density may be regarded as uniform throughout. However, in many problems the entire flow is due to density differences resulting from temperature gradients, and for exact results it is obvious that the large variations in viscosity resulting from temperature inequalities must be taken into consideration.

For the application of dimensional analysis, we take the density at some convenient point in the unit as a reference value and express densities at all other points as dimensionless ratios times this reference density. The viscosities at all points are also expressed as ratios to a reference viscosity chosen at some convenient point. Practically, we measure or infer the temperature at a sufficient number of points so that when densities and viscosities are computed or estimated at these points from the temperatures, the over-all distributions of density and viscosity are well enough known. In some problems, pull may be expressed as weight of glass per unit of time, in others, as volume per unit of time. In some problems pull is 0 (zero). We may consider pull in volume per unit of time only, without loss in generality. If the flow is divided between several exits or entrances, the ratios between pulls through the various openings are dimensionless ratios.

Dimensional Analysis

For mathematical treatment it is convenient to express these variables by the following notation. The physical dimensions of the variables are also given.

V = the velocity component desired. Dimensions $= L/T$.

L = principal dimension or length of the unit. Dimension $= L$.

$l_1 l_2$ = dimensionless ratios of the other lengths to the principal length.

D = density of the glass at reference point. Dimensions $= M/L^3$.

$d_1 d_2$ = dimensionless ratios of densities at many other points to reference density.

N = viscosity of glass at reference point. Dimensions $= M/LT$.

$n_1 n_2$ = dimensionless ratios of viscosities at many other points to reference viscosity.

P = pull or fill rate for unit. Dimensions $= L^3/T$.

$p_1 p_2$ = dimensionless ratios of any divided streams which may be drawn from the unit or filled into it.

R = angular velocity or rate of rotation of one sleeve or stirrer. Dimensions $= L/T$.

$r_1 r_2$ = ratios of other rates of rotation to the one.

U = velocity of needle, etc., an independent variable as contrasted with V the dependent variable. Dimensions $= L/T$.

$u_1 u_2$ = ratios of other independently variable velocities.

T = time. Dimensions $= T$.

G = acceleration of gravity. Dimensions $= L/T^2$.

In solving the problem proposed, it will be necessary to apply the laws of hydrodynamics and of viscous flow to obtain the applicable differential equations. This first step is generally relatively simple. The real difficulty arises in integrating the differential equations with the given boundary conditions. Exact solution is usually impossible, and even plausible approximations, *e.g.*, by the method of relaxations, involve prohibitive amounts of algebraic and numerical work.

However, it is clear that if the problem were solved, the solution would have the following form.

$$V = F\ (L, l_1\ l_2, \ldots, D, d_1, d_2, \ldots, N, n_1, n_2, \ldots, P, p_1, p_2, \ldots, R, r_1, r_2, \ldots, U, u_1, u_2, \ldots, T, G)$$

This is simply a mathematical statement that V depends upon the variables enumerated above. Applying the *Pi* theorem, this becomes

$$V = L/T\ f\ [\ (C\ GT^2/L),\ (DL^2/NT),\ (PT/L^3),\ (RT),\ (UT/L),\ l_1,\ l_2, \ldots, d_1, d_2, \ldots, n_1, n_2, \ldots, p_1, p_2, \ldots, r_1, r_2, \ldots, u_1, u_2, \ldots\ ]$$

This result of dimensional analysis tells almost nothing at all as far as solving the problem is concerned. The velocity is proportional to the length of the unit divided by the time of observation times an entirely arbitrary function of five dimensionless products and countless dimensionless ratios.

However, we may construct a model of the glass unit in which all of the arguments of the function f have exactly the same values as in the actual glass-producing unit. As far as the dimensionless ratios l_1, l_2 . . . are concerned, this is usually expressed by saying that the model is "similar" to the unit. Making the d's the same means that the distribution of density is similar in the model to that in the unit. That is, if the density of the glass at some particular point in the unit is 2 per cent less than at the point which has been selected for measuring the reference density, than the density of the fluid in the model at the model point corresponding to the particular point in the unit must be 2 per cent less than the density of the model fluid at the model point corresponding to the reference point in the unit. Similarly for viscosities, if the viscosity of the glass in a corner of the unit is twice that of the glass at the reference point in the unit, which may have been chosen as the exact center of the unit, then the model fluid must have in the corresponding corner twice the viscosity of the model fluid at the exact center of the model.

From point to point in the unit, the variations of

glass density and of viscosity depend on the temperature. Control of the temperature at the corresponding points in the model appears to be the only practical means of producing the "similar" gradients of density and viscosity which are necessary in the model fluid. However, this introduces a restriction in the choice of the model fluid which may be difficult to meet. Over the range of viscosities and densities similar to those encountered in the actual unit, the model fluid must show the same proportional changes in both properties. If the glass in the unit at a specific point has a temperature such that its viscosity is twice that of the glass at the reference point and its density 102 per cent of the density of the glass at the reference point, then the model fluid at the model point corresponding to the specific point in question must have twice the viscosity of the model fluid at the model point corresponding to the reference point and 102 per cent of the density of the model fluid at the model reference point.

In general, it should be possible to adjust the temperature of the model fluid at the specific point to meet one of these requirements, but after the temperature is adjusted so that the density, for example, is correct, it will depend upon a fortunate choice of model fluid if the viscosity is also correct. In problems involving convection it appears that maintaining the correct density gradients is the more important consideration, and it may be possible to obtain useful results in models even though it is not possible to find a model fluid which has quantitatively the right change in viscosity to match the viscosity gradients needed in the model.

It is proposed to adjust the temperature gradients in the model so that the viscosity and density gradients are similar to those in the glass unit. Radiant energy, conducted heat, or Joule energy may be used to do this. When the glass unit is in a steady state so that temperature and temperature gradients do not change with time, setting up the desired temperature conditions in the model will be easier than when the problem involves glass temperatures changing with time. Indeed, it is probably impossible to do useful model work on glass problems involving setting up of the glass, such as pressing gobs or drawing tubing. There is no means of getting the very rapid heat transfer from the model liquid that occurs from the glass.

Setting up the proper relative rates of pull, sleeve rotation, and plunger velocity for the model is straightforward. In some problems, relative rates of pull at two or more outlets may be dependent variables to be determined by the experiment with the model. In other problems, the p's may be treated as independent variables and the relative flows out of the several outlets adjusted by valves outside the model proper so that the p's have the same values for the model as in the actual unit. Having adjusted the dimensionless ratios (l_1, l_2, . . . , d_1, d_2, . . . , n_1, n_2, . . . , p_1, p_2, . . . , r_1, r_2, . . . , u_1, u_2, . . .) so that they are the same in the model as in the actual glass unit, we must also make the five dimensionless products, which are arguments of the f function, equal in the model and unit. Quantities pertaining to the model will be designated by a subscript m.

The scale of the model s is given by the ratio of the principal model dimension L_m to the principal dimension of the glass unit L. Thus

$$s = L_m/L$$

Making the first product under the function sign the same in model and unit yields the equation

$$GT^2/L = GT_m^2/L_m$$

G, the acceleration of gravity, is of course the same for model and unit. Hence

$$T_m/T = (L_m/L)^{1/2} = s^{1/2}$$

A concrete example of what this equation means may be given as follows. If we construct a model one-quarter the size of the glass unit being studied, the time scale will be one-half. That is, the flow which takes place in 1 minute in the unit will require 30 seconds in the model.

The second dimensionless product under the function sign yields the relation

$$DL^2/NT = D_m L_m^2/N_m T_m$$

$$N_m/D_m = (N/D)(T/T_m)(L_m^2/L^2)$$

$$= (N/D)\, s^{-1/2} \cdot s^2$$

$$= (N/D)\, s^{3/2}$$

This means that the kinematic viscosity varies as the 3/2 power of the scale factor. For a quarter-scale model, the kinematic viscosity of the model fluid must be one-eighth that of the glass at the reference point.

From the third term of the function we have

$$PT/L^3 = P_m T_m/L_m^3$$

or

$$P_m/P = (T/T_m)(L_m^3/L^3)$$

$$= s^{5/2}$$

For a quarter-scale model, the pull or fill must be only one-thirty-second the pull on the full-sized unit.

The fourth term of the function yields the relation

$$RT = R_m T_m$$

$$R_m/R = T/T_m = s^{-1/2}$$

This indicates that sleeves, stirrers, etc., must rotate twice as fast in a quarter-scale model as in the full-sized unit.

The fifth term gives

$$UT/L = U_m T_m/L_m$$

or

$$U_m/U = (T/T_m)(L_m/L) = s^{1/2}$$

That is, the velocity of any feeder parts or other driven parts must be half as great in the quarter-scale model as in the unit. This is consistent with the relation for speed of rotation; the peripheral velocity of a quarter-scale sleeve, for example, will be half that of the full-sized sleeve if it is driven at twice the angular velocity.

When these conditions have been met, all of the variables upon which the function f depends will have the same value in model and full size unit. Hence

$$f = f_m$$

and

$$V = (L/T)\ f\ [(GT^2/L),\ (DL^2/NT),\ \ldots]$$
$$VT/L = f = f_m = V_m\ T_m/L_m$$
$$V_m/V = (T/T_m)\ (L_m/L) = s^{1/2}$$

Thus, the observed velocities in a quarter-scale model will be half the corresponding velocities in the full-sized unit.

Case of Slow Flow

More freedom in choosing the fluid for the model may be had by restricting the problems considered to those in which the flow is purely viscous and the relationship between force and mass times acceleration does not enter. In many cases where the glass flow is streamline and nonturbulent, a dimensional analysis in which force is taken as a fundamental unit may be applied. It must be remembered, however, that centrifugal force is a result of the radial acceleration due to uniform rotational movement, so that the following less restrictive analysis is valid only when rotating elements such as stirrers move so slowly that centrifugal forces in the moving glass do not appreciably influence the flow pattern.

When force F is considered as a fundamental unit and not as a secondary quantity defined by the relation

$$F = ML/T^2,$$

two of the dimensional formulas for the variables in the flow problem are changed, *vis*

$$N = FT/L^2$$
$$G = F/M$$

With the four fundamental units M, L, T, and F instead of only three, M, L, and T, the number of dimensionless products which can be formed from the variables upon which the velocity depends is reduced by one. In the new analysis we have

$$V = (L/T)\,q\,[(DGTL/N), (PT/L^3), (RT), (UT/L),$$
$$l_1,\ l_2,\ \ldots,\ d_1,\ d_2,\ \ldots,\ n_1,\ n_2,\ \ldots,$$
$$p_1,\ p_2,\ \ldots,\ r_1,\ r_2,\ \ldots,\ u_1,\ u_2,\ \ldots]$$

where q is an arbitrary function. The condition of similarity must be met just as before by making the dimensionless ratios l_1, l_2, . . . , etc., the same for model and full-sized unit.

From the first dimensionless product under the function sign we obtain

$$DGTL/N = D_m\ G\ T_m\ L_m/N_m$$

or

$$T_m/T = (N_m/D_m)\ /\ (N/D)\ (L/L_m)$$

We may take any scale factor $s = L_m/L$ and any convenient ratio of kinematic viscosities $(N_m/D_m)\ /\ (N/D) = k$, and by choosing the proper time scale for the model, make the first argument of the q function the same for model and full-sized unit. In particular

$$T_m/T = k/s$$

For example, with a quarter-scale model, if the kinematic viscosity of the model fluid is equal to that of the glass, the time scale for the model will be four times as long as for the large unit. For the flow that takes place in 1 minute in the unit, 4 minutes will be required in the model. Proceeding as before, we find

$$P_m/P = s^4/k$$
$$R_m/R = s/k$$
$$U_m/U = V_m/V = s^2/k$$

We are free to select any desired scale factor s and any desired kinematic viscosity ratio k as long as the viscosity is great enough so that turbulent flow is avoided and centrifugal force does not appreciably affect the results. If the kinematic viscosity ratio and other independent variables are selected according to the previous set of equations so that they are determined for the model by the glass properties and the scale factor s, only then will the flow pattern in the model be similar to that in the full-sized unit, even though turbulent flow exists or the rotation of sleeves and stirrers is sufficiently rapid so that the centrifugal force in the glass and model fluid play a part in determining the flow pattern.

General Discussion

In a paper entitled, "The Use of Models for Studying the Circulation in Glass Tanks,"[1] Dr. Buckingham discusses the problem of setting up a model similar to a large glass tank in such a way that the flow through the volume of the model will be made similar to that of the glass in the large tank by choosing a model fluid with suitable thermal properties and adjusting the surface temperatures of the model fluid to be similar to the surface temperatures of the glass. He neglects variations in viscosity from point to point in the tank and model, considering only the viscosity at some mean temperature. The thermal conductivity of the tank walls is modeled and the outside temperatures of the tank are reproduced by a similar distribution of temperatures on the outside of the model. He neglects the inertia forces in comparison with the viscous forces. He assumes that the glass is so opaque to radiant energy that the temperature below the surface is determined entirely by conduction and convection.

Buckingham thus attempts to use a model to solve two problems simultaneously: *(1)* the temperature distribution in the interior of the glass mass, and *(2)* the flow pattern resulting from this temperature distribution. The point of view taken in the present analysis of the problem is to determine experimentally the temperature distribution in the glass in the large unit and employ the model to learn what convection currents result. Although Buckingham concludes that it is hopeless even with his extreme simplifying assumptions to try to find a model fluid which will have the necessary combination of physical and thermal properties, it seems probable that

(*Continued on page* 663)

1. Jour. Amer. Ceram. Soc., *20*, 1, 1937.

Intarsia vase by Frederick Carder. Collection of the author.

INTARSIA GLASS

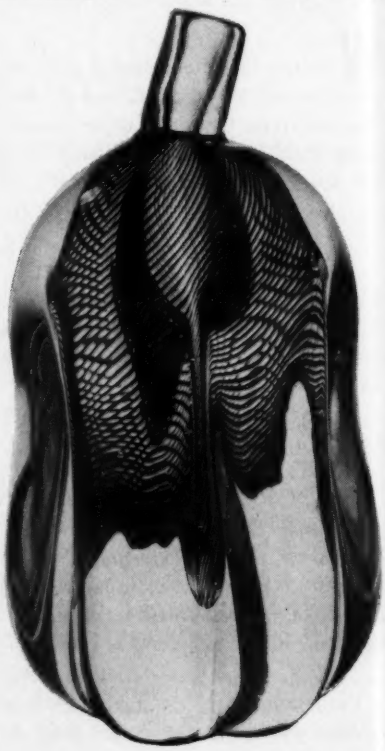
by Albert Christian Revi

From 1916 to 1923 Frederick Carder, cofounder of the Steuben Glass Works at Corning, N.Y., produced artistic-glassware emulating those decorative designs created by inlaying wood in a background of wood and known as "intarsia." To make his intarsia glasses, Carder formed a small bulb of glass on the end of an iron and coated it with any desired color. The colored casing was then etched into a pattern. Thereafter, the bulb was reheated slowly, picked up on the blow iron, and blown out larger. It was then blown into a cup of crystal glass made to receive it, and the two, cohering, were blown out to the shape and size required. The stem or foot was attached and the article annealed.

In 1917 the Orrefors Glassworks of Orrefors, Sweden, featured a display of Simon Gates' Graal glass at Nordiska Kompaniet, a department store in Stockholm with world-wide outlets. The Graal glass consisted of several thin layers of colored glass, cleverly etched into pleasing designs and plated with a skin of crystal glass to leave a smooth exterior. In the 1930's Vicke Lindstrand and Edward Hald of Orrefors revamped the Graal technique, applying a thick layer of clear glass over an etched layer of colored glass, the decorative pattern being reflected in a striking play of colors.

At an exhibition in Paris in 1937, Edvin Ohrstrom's Ariel glass made its appearance along with some fine examples of his Graal glass. The new Ariel glass resembled the Graal technique, but differed in its use of patterns of bubbles as part of the decoration. Interesting figure and flower compositions, rich in color, were combined with the silvery gleam of air bubbles to give Ohrstrom's creations a scintillating texture.

During the Nineteenth Century several patents were issued covering similar decorative productions in glass. On May 25, 1850, Edward Pettitt of Birmingham, England, registered his method for rolling plates of window glass with ornamental designs sandwiched between two layers of glass. Pieces of colored glass which had been previously stamped, cast, or cut into ornamental forms were applied to a sheet of glass and thereafter another sheet of glass was either cast or rolled over the ornamental design. Pettitt suggested in his enumerations that *(1)* the colored pattern could be applied to a background of opaque white or colored glass, or *(2)* a pattern could be drawn on a plate of glass with plumbago and connected to a galvanic battery for the purpose of depositing



Graal glass vase by Edward Hald. Collection of Orrefors Glass Works.

a metallic design which would afterward be covered with another layer of glass.

On April 6, 1853, "a communication from abroad" was registered at the Patent Offices in London by William Johnson of Glasgow, Scotland. (Mr. Johnson acted as agent only, and a careful search of the patent records offers no clue to the actual patentee). The invention related to the production of ornamental surfaces by in-

Graal glass vase by Edward Hald. Collection of Orrefors Glass Works.

crustation or "inlaid work [intarsia]." Two pieces of different colored glass, laid one upon the other, were united by heat; they were then softened in an enamelling furnace, and a design of any kind impressed on their surfaces. By this means the upper colored piece was squeezed into, and partially penetrated, the lower one according to the design on the impressing die. The entire surface was then ground flat and the superfluous glass cut away, leaving the actual design imbedded in the lower piece of glass.

In another method, the die employed was simply a punch corresponding in outline to the contour of the design. A number of plates of glass of uniform thickness, but of different colors, were perforated by this punch, and the pieces so cut out were exchanged and inserted into corresponding holes in the different plates. Thus, a piece cut from a blue plate was inserted into an opening in a red plate, while the piece from the red plate was inserted into the corresponding opening of the blue plate, and so on throughout the series, with different colored glasses being inlaid together to form varied and colorful designs. The intarsia techniques registered by William Johnson closely resemble the inlaid mosaic glass productions of the early Egyptians. They also represent a rare and interesting development in the pressed glass industry.

Achille Lemaire of Paris, France, registered his means for producing intarsia glass July 14, 1879. The patent received only provisional protection at the London Patent Offices. In carrying out his invention, Lemaire painted a design with enamels on a "show" or blown piece. The bulb thus ornamented was plunged into a pot of molten glass to become covered with a layer of metal and was then blown into shape. The design, being applied to the "show" when in a miniature condition, enlarged as the parison was expanded. Instead of painting the designs on the blow, Lemaire suggested that they be cut, engraved, molded, or applied by a galvanic or photographic agency. Etching an applied colored layer of glass prior to applying a second skin of glass, as Carder has done, was also suggested. Applying "cameos" to the bulb before coating it with a heavy layer of glass was still another method Lemaire employed in his production of intarsia glassware.

On November 8, 1883, Lewis John Murray of the Soho and Vesta Glass Works, Birmingham, England, registered a means for producing intarsia glass closely resembling the procedure used by Frederick Carder and Simon Gates. Murray etched, engraved, or sand-blasted the design on a blow, plated with colored glass, before blowing it into a cup of glass, thereby entrapping the colored design be-

Ariel glass vase by Edvin Ohrstrom. Collection of Orrefors Glass Works.

tween two layers of clear crystal glass. He registered his patent in America on December 23, 1884.

There are relatively few factories in operation today that can boast such intricate productions as intarsia, Graal, and Ariel glass. Consequently, the entire industry views with pride the artistic contributions of such Twentieth Century craftsmen as Carder, Gates, Lindstrand, Hald, and Ohrstrom.

In addition to being contributing editor for The Spinning Wheel, *Albert Christian Revi is also the author of many articles on glass appearing in other magazines. His first book,* Nineteenth Century Glass — Its Genesis and Development, *was puublished in 1959 by Thomas Nelson & Sons, New York. A second book,* American Pressed Glass and Figure Bottles, *will be released this coming Spring.*

Calibration Of Optical Pyrometers

Optical pyrometers are used widely in the glass industry for checking roofs, walls, and flue linings of ovens, kilns, and furnaces, and for determining temperature gradients in glass tanks.

Optical pyrometers are instruments used to measure the brightness temperature of incandescent objects, and to realize the International Practical Temperature Scale above 1063°C. The National Bureau of Standards, as part of its program to insure accurate and uniform measurements, calibrates these instruments for science and industry.[1] These calibrations are performed over the temperature range of 800 to 4200°C; the uncertainty of the calibration varies from about 3°C (at 1063°C) to 40°C (at 4200°C). In addition, the Bureau calibrates tungsten strip lamps for use as sources of known brightness temperature over the range of 800 to 2300°C.

In general, an optical pyrometer[2] consists of an optical system, through which the object whose temperature is being measured is viewed, and a power supply used to apply a variable current to a thin tungsten filament within the optical system. The current is adjusted until the filament disappears in the background of the object being viewed, at which time either temperature, voltage, or current can be read from the current-controlling dial. A red filter is placed in front of the eyepiece to insure that a limited range of wavelengths is being viewed. Because the maximum brightness temperature attained with the tungsten filament is about 1350°C, provision is made to place absorbing filters in the optical system (either in front of the foremost objective or between the objective and the filament lamp) to permit measurement of higher temperatures.

NBS Pyrometer

The NBS pyrometer, against which other pyrometers are compared, was given a primary calibration involving a large number of observations (by several different observers) of a black body cavity surrounded by freezing gold, the temperature of which is defined as 1063°C on the International Practical Temperature Scale. In addition to this single-point determination, the calibration was extended to higher and lower temperatures by the viewing of a tungsten strip lamp at different brightness

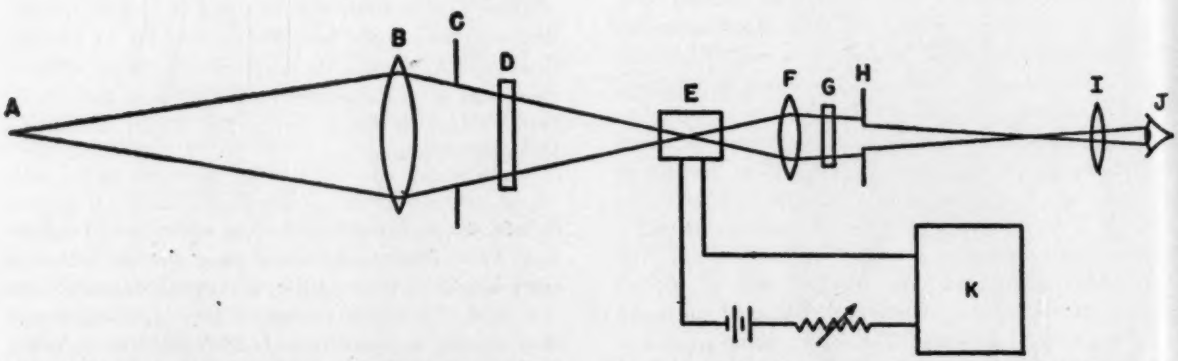


Diagram of a typical optical pyrometer. Radiation from source A enters optical system through objective B and passes through aperture C. Absorbing filter D is used when making temperature determinations above upper limit of filament lamp E. Radiation from both source and lamp passes through microscope objective F, red filter G, aperture H, and eyepiece I to eye of observer. Potentiometer network K is used to measure current in lamp E. A brightness match is made by adjusting current to make filament disappear in background of source.

temperatures, the temperatures being determined by the matching of lamp brightness through rotating sectored disks of known transmissions with the black body (1063°C). The pyrometer lamp current corresponding to the various temperatures was determined with a potentiometer. The same type of circuit is used to measure the currents in the filaments of test pyrometers during calibration.

Calibration Procedure

Instruments submitted for calibration are compared with the NBS pyrometer while a tungsten strip lamp (used for up to 2400°C brightness temperature) or zirconium and carbon arcs (used where higher temperatures are desired) are viewed. The brightness temperature of the zirconium arc is about 2800°C, and that of the positive crater of the carbon arc is about 3530°C. In setting up the pyrometers for a comparison calibration, the optic axes of the test and NBS pyrometer are made parallel. The source is mounted on a lathe bed, and mechanically transported to alternate positions in front of the two pyrometers. The source is adjusted so that the image of its sighting area is coincident with the sighting area of the filament lamp in each pyrometer.

Before observations begin, the source is allowed to stabilize; this takes only a few minutes for the arcs, but an hour is allowed for the strip lamp to become stable. Then, in a darkened room, the source is positioned in front of the NBS pyrometer. Two observations are made, and the source is then transferred to its position in front of the test pyrometer. Four observations are made with the test pyrometer, then two more with the standard. This series is repeated with a second obsrver. Measurements are made from both sides of disappearance, starting with the filament both brighter and darker than the source.

When a strip lamp is used as the source, the constancy of the lamp brightness is assured throughout the comparison by the monitoring of the lamp current. Also, when a series of readings is being made with a strip lamp, the lamp is brought to the highest temperature first, then decreased; this procedure results in the shortest stabilization times between settings. The results of the calibration are reported to the user on an NBS certificate. Usually, the scale reading of the test pyrometer corresponding to black body temperature is listed. However, temperature versus current or voltage may be reported if requested.

Strip Lamp Calibration

Lamps consisting of a strip of tungsten housed in a gas-filled envelope are calibrated by means of brightness temperature determinations made with the NBS pyrometer. The lamp and pyrometer are aligned as in pyrometer calibration, and after a warm-up period, the strip lamp current is determined at the same time that a pyrometer observation is made. Four observations are made by two observers at each point of the calibration. The lamp current vs. brightness temperature (as determined with the NBS pyrometer) is reported to the user.

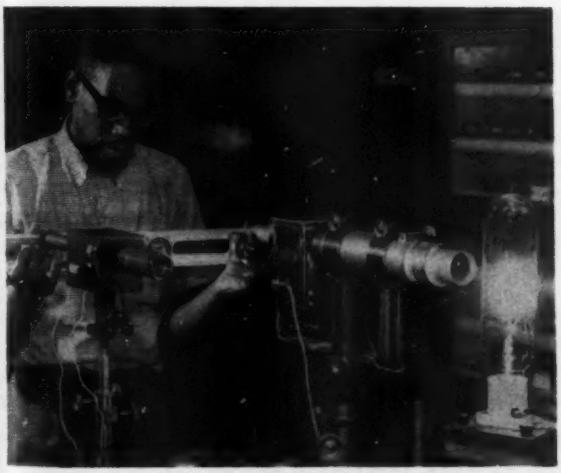
A photoelectric pyrometer that uses a photomultiplier tube rather than the human eye to make brightness matches between sources of interest and the pyrometer lamp has recently been developed at NBS. After proper testing and calibration, this device will be used in the calibration of pyrometers and strip lamps. It will eliminate the variability in these calibrations that is presently due to the lack of precision of the observer.

REFERENCES

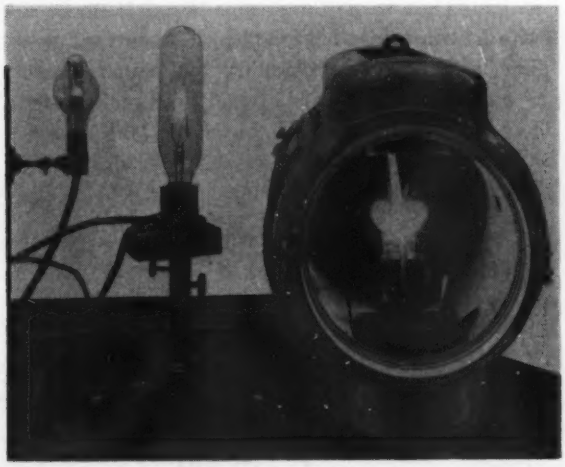
[1]Test fee schedules of the National Bureau of Standards, available from the Office of Technical Information, National Bureau of Standards, Washington 25, D.C.

[2]H. J. Kostkowski and R. D. Lee, "Theory and Methods of Optical Pyrometry," presented at the Fourth Temperature Symposium, Columbus, O., March 1961; to appear in *Temperature—Its Measurement and Control in Science and Industry*, Vol. 3, Reinhold Pub. Co.

[3]R. D. Lee, "The NBS Photoelectric Pyrometer of 1961," *loc. cit.*



NBS pyrometer (right) is aligned with test pyrometer prior to calibration. A series of readings will be taken with each instrument while sighting on tungsten strip lamp (extreme right.) At higher temperatures, zirconium and carbon arcs serve as brightness temperature sources.



Brightness temperature of the zirconium arc (left) is fixed at about 2800°C, while that of the positive crater of the carbon arc (right) is about 3530°C. Brightness temperature of the strip lamp (center) is varied during calibration from 800°C to 2400°C.

Cambridge Cambriloy-Al

METAL-MESH FEEDER BELT

CUTS CHECKING, CUTS COSTS, CUTS PRODUCTION LAGS

Because quality glassware production has to keep going full tilt to meet today's demands, efficient processing is a must. Cambridge Metal-Mesh Feeder Belts help increase efficiency in 3 important ways. They improve product quality by reducing checking and marking of ware carried from mold to lehr. They lower operating costs by giving longer service life. They insure continued high production by cutting down-time and maintenance.

And, because of recent aluminum developments, you'll want to hear the full story on the higher tensile strength and lower cost of Cambridge Cambriloy-Al Feeder Belts.

There is a complete line of Cambridge Belts in special and standard metals and alloys to meet your specific requirements—custom built in any weave to insure the most efficient processing.

Experienced Cambridge Field Engineers—experts in their field—are available to discuss your needs and help you select the belt best suited to your operations. Or, they can offer you sound advice on the installation, operation and maintenance of your Cambridge Belts. Talk to your Cambridge man soon. He's listed in the Yellow Pages under "Belting, Mechanical". Or, write for free 130-page reference manual.

The Cambridge Wire Cloth Co.

DEPARTMENT K • CAMBRIDGE 11, MD.

Manufacturers of Metal-Mesh Conveyor Belts, Flat Wire Conveyor Belts, Wire Cloth, Wire Cloth Fabrications, Gripper® Metal-Mesh Slings

Back in 1947, a large sheet of translucent material, created from fiber glass for experimental purposes, was left lying in the corner of a California quonset hut then serving as an office area. To obtain more light over his desk, an employee removed a section of roofing and replaced it with the translucent panel. Others saw and were impressed; an industry was born.

FGRP panels add a note of elegance to the home . . .

FGRP PANELS: Experiment That Launched an Industry

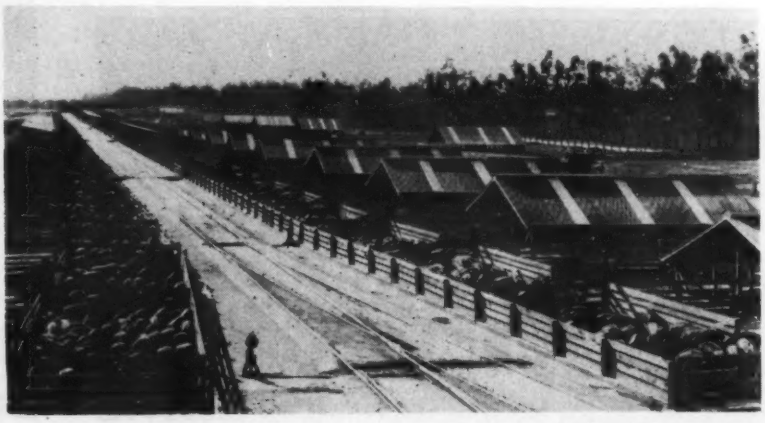
by ***David S. Perry,*** president, Filon Plastics Corp., Hawthorn, Calif.

Within months after the ingenuity of one man first demonstrated the potential of fiber glass as a building material, FGRP panels were being manufactured by a small West Coast company for use as skylights in Naval quonset hut roofing. That was 14 years ago. Today, fiber glass reinforced plastic panel installations, once considered unusual, are appearing everywhere in an endless variety of forms: skylights, side lights, glazing for factories, farms, greenhouses, and commercial establishments; signs, marquees, fences, carports, shoji screens, luminous ceilings in homes and offices, to name but a few. Output of FGRP panels this year is expected to be in the neighborhood of 100 million sq. ft.; next year production is forecast to reach 120 million sq. ft.

For several years the annual growth rate of the industry has been from 15 to 20 per cent, and it is felt that this expansion will continue at approximately the same rate. However, if the industry's full potential is to be realized, there are several problems which will have to be studied and overcome. One of these is research and standardization.

There is now, and has been for some time, a trend toward fewer manufacturers producing a larger percentage of the total industry output. Two years ago, there were 80 to 100 fabricators of FGRP panels in this country with 10 of them turning out 80 to 85 per cent of the gross product; today, 8 of the remaining 50 to 60 manufacturers account for 85 per cent of over-all industry production. Basically, this change reflects the increasing demand for higher standards in quality control and improved processes and materials. Those companies which have not met this challenge are suffering a high mortality rate.

Extensive research and development programs are necessary to investigate resin properties and improve production facilities so that FGRP panels can not only compete with the materials they are striving to replace, but also satisfy present consumer needs while exploiting future application possibilities. For example, polyester



. . . and are becoming a familiar sight on the farm.

Fiber glass can brighten a school cafeteria . . .

. . . illuminate a commercial sign or display . . .

resin is essentially the most stable and practical for use in FGRP panels. Yet, after several years of outdoor exposure, particularly in severe climatic conditions, panels will show visible signs of *(1)* "blooming" (erosion of protective resin causing dirt and moisture to adhere to exposed fibers), *(2)* slight yellowing or fading with consequent loss of original light transmission values, and *(3)* loss of surface gloss. In an effort to eliminate these deficiencies, several manufacturers have applied a protective resin coating *after* the curing process. This creates a *mechanically* bonded surface coating which frequently chips, cracks, and peels. On the other hand, a *chemical bond* provides a coating that is actually an integral part of the panel. With "Filon" panels, this is achieved by bonding a light-stable acrylic-modified resin to the basic polyester core during production *prior* to the actual curing process.

Another problem facing the FGRP panel industry is that of "educating" local authorities responsible for writing building codes. In this area, there is no substitute for an organized, informative, and intensive program aimed at establishing specifications based on the actual performance of fiber glass rather than on comparative figures involving the older, more limited plastics and materials such as wood. The fact that Factories Mutual Lab. underwrites a large percentage of industrial building insurance for structures in which FGRP panels are used in up to 25 per cent of the area without sprinklers, and throughout an area with sprinklers, is overlooked by many code-writing groups.

To combat these failings, The Society of the Plastics Industry, Inc., has, for several years, had a special code advisory committee working closely with code organizations. To date, considerable progress has been made, but local code groups still show some hesitation. If the structural strength capabilities of fiber glass are to be recognized and accepted, it is essential that each manufacturer assume the responsibility of maintaining high standards, improving his product, and informing the public of the changes which are taking place in this dynamic new industry.

. . . serve to light an industrial area . . .

. . . or lend softly-diffused beauty to a church.

Working around-the-clock, seven days a week, four CF&I-Wissco woven wire conveyor belts provide Underwood Glass Company with trouble-free service under unusually demanding operating conditions. The company manufactures bottles in practically every conceivable size and shape.

Famous Names ride on WISSCO BELTS

And at Underwood Glass the ride never stops

How's this for a conveying problem?

You need four belts that must operate 24 hours a day, seven days a week. They must be constantly submitted to temperatures as high as 1100°F and then immediately cooled to 100°F as they enter and leave lehr ovens. Downtime can't be tolerated.

The answer? Mr. P. H. McCrocklin, service manager at Underwood Glass Company, puts it this way:

"Since the plant opened four years ago we have been using CF&I-Wissco steel mesh conveyor belts exclusively. Despite our unusual demands, these belts have given us trouble-free service . . . vital to us because there is no way to find and correct trouble in these long, hot ovens."

Combining quality and sound construction for long service life, Wissco Belts withstand the wear and tear encountered in lehr operations. A number of designs are available, all incorporating Wissco's exclusive thin, flat spiral and welded knuckle edge for improved operation with minimum maintenance. For the complete story on Wissco Lehr Belts for ceramics and glass annealing and decorating, contact Wickwire Spencer Steel Division, Woven Wire Products Sales Department, P. O. Box 311, Palmer, Mass.

Steel

For a variety of durable industrial products

The Colorado Fuel and Iron Corporation
Denver • Oakland • New York
Sales offices in Key Cities

Reader Service Card: Circle No. 24

NEWS

Pictured at the dedication of the Owens-Corning research center are (l. to r.) Games Slayter, vice-president, Harold Boeschenstein, president, dedicatory speaker Dr. Frederick L. Hovde, president of Purdue University, and Maj. Gen. Richard D. Meyer, deputy chief of staff.

Special X-ray equipment is being used to study glass composition in the technical center.

Owens-Corning Fiberglas Corp. Dedicates Technical Center

The firm's new multimillion dollar research center at Granville, O., has been dedicated to Games Slayter, "father of the glass fiber business in America." Slayter, vice-president of research for Owens-Corning, has more than 35 patents to his credit, most of which were issued within the past 30 years as a result of glass fiber research. He is the author of numerous scientific articles, the recipient of several awards from national scientific and educational organizations, and largely responsible for the development of practical uses for fiber glass. He is presently directing the company's pioneering laboratory.

Glasspar Co. Launches New Operation

A 51,000-sq.-ft. facility at Sturgis, Mich., has begun manufacturing operations which will serve Midwest markets. Glasspar, producer of fiber glass outboard boats, has been using the installation for warehousing since its completion in May of this year.

Johns-Manville Honors One, Promotes One

William P. Hahn, technical manager for the firm's Fiber Glass Div., has been inducted into the company's Quarter Century Club. Located in Toledo since 1959, when he transferred from the research center in Manville, N. J., he is currently in charge of product planning, technical and experimental activities in product and process development, and technical assistance for new products.

Charles J. Rossio, with J-M industrial sales since 1936, has been named to handle the sales of fiber glass textile products in the southern California area. He was most recently Seattle district sales manager, pipe division.

Crichton C. Callaway

An executive in the management group at Owens-Corning Fiberglass Corp. for 18 years, has joined the firm of Charles Luckman Assoc. He will serve as vice-president in charge of the planning-architecture-engineering company's office building division.

Fibrous Glass Products, Inc., Building New Plant

A $1.8 million plant designed to produce basic materials and turn out a wide range of finished products is under construction near Wilkes-Barre, Pa. The facility, located on a 13-acre site in the Crestwood Industrial Park of Mountaintop, will contain 58,000 sq. ft. floor space. The company, a subsidiary of Pall Corp., is already shipping finished products from the new installation, and the glass fiber manufacturing system is scheduled to be put into operation early next year. Capacity is expected to reach 10 million lb. of fiber glass per year.

Fibrous Glass will combine fiber manufacture with insulation, molded pipe, and filter fabrication.

fmc® SODA ASH FLOWS "FREE & EASY"

for faster handling

You save time unloading FMC Soda Ash and in getting it from bins or silos into operations.

The reason is simple. FMC Soda Ash is composed of roller-shaped crystals that don't lump up, stick or bridge over. Besides flowing freely, these crystals don't degrade into fines. They make FMC Soda Ash virtually dust-free.

Other features of FMC Soda Ash: Consistently high purity, fast dissolution, low iron and no ammonia content. And you get fast, reliable shipment in our own covered hopper cars.

You can enjoy the advantages of premium-quality FMC Soda Ash and it will cost you no more. Why not ask for our quote?

fmc CORPORATION®

CHLOR-ALKALI DIVISION

161 E. 42nd Street, New York 17

Reader Service Card: Circle No. 25

Applications...

Decorative fabric is attached, insulation layed up, and assembly moves on to press in back.

After 3½-minute cure in press, fiber glass fabric and insulation are molded into one piece.

Rough edges are trimmed, center hole for dome light is cut, and headliner is ready for shipping.

HEADLINER for the Rambler Classic and Ambassador models will again be made of laminated fiber glass this year.* The 1962 snap-in, one-piece acoustical ceiling has a new criss-cross pattern to reduce soiling, and will appear in a variety of colors to match upholstery. Altogether, 1,717,165 lb. of fiber glass were used in American Motors' cars in the 1961 model year. This figure includes both the compressed fiber glass insulating material and the fiber glass trim fabric. A breakdown appears in Table I.

TABLE I—Fiber Glass Used in 1961 Models by American Motors†

Classics and Ambassadors	Number Cars Produced‡	Lb. Fiber Glass per Car	Total Lb. Fiber Glass
Sedans	150,488	5.625	846,495
Station Wagons	91,411	9.525	870,690
TOTAL			1,717,165

†Compiled with the cooperation of F. J. Solon, Jr., Solon Associates, Toledo, O.
‡Car production figures from *Ward's Automotive Reports.*

According to Owens-Corning Fiberglas, the following are some of the new fiber glass applications found in 1961 model cars.

- Simulated wood rails for exterior of Falcon station wagon.
- Garnish moldings for Econoline bus, deluxe only.
- Tonneau cover for rear seat area of Thunderbird.
- Instrument panel extension for shielding instruments from passenger's view in Econoline bus, deluxe only.
- Molded storage boxes in Ford diesel truck cabs.
- Transmission cover plate for large Ford trucks.
- Delivery and air intake ducts for GMC coach air conditioners.
- 1962 Corvette bodies
- 1962 White Series 500 truck cab bodies.
- Water tank for Dodge motor home, which has the chassis of a truck and functions as a mobile home. *Johns-Manville Fiber Glass Div. and Owens-Corning Fiberglas Corp.*

Reader Service Card: Circle No. 50

REINFORCEMENT FOR ENAMEL is now being fabricated of glass fibers and yarns pressed into a mat. Called "Coromat," this inner wrap is designed to keep corrosive moisture away from gas and oil lines in the soil. A new binder applied to the fibers and yarns is claimed to make the mat more flexible, and therefore easier to handle. *Owens-Corning Fiberglas Corp.*

Reader Service Card: Circle No. 51

CEILING UNITS of fiber glass combine sound control and a third-dimensional quality. The new design consists of 2-ft. square molded panels which rise gently to a vaulted center. Called "Acousti-Shell," they are available in standard white, blue, and green, or may be dyed different colors and printed with custom designs on special orders. Said to be extremely strong and rigid, these shells are about one-third the thickness of flat sound control panels, and they absorb up to 80 per cent of the room noise striking them. *Johns-Manville Fiber Glass Div.*

Reader Service Card: Circle No. 52

Here "Acousti-Shell" sets off the interior of a cafe.

*See "Fiber Glass Headliner for Cars," THE GLASS INDUSTRY, 41 (October, 1960), 563.

Global Acceptance for FC-101, Fusion Cast Refractory

Fusion Cast and other Walsh Refractories palletized for shipment to foreign ports.

In the short span of approximately 19 months, the acceptance accorded by glass manufacturers to FC-101, Premium Fusion Cast Refractory, has been nothing short of miraculous.

Normally, the Glass Industry is understandably slow to approve a new refractory, and for good reason. Life of the furnace lining, estimated potential tonnage, glass quality and a host of other considerations hang in the balance.

Hence, the relative speed with which this quality product has won unqualified approval is proof of its superior purity, higher P. C. E., greater spall resistance, minimum of voids, its maximum weight per cubic foot and its extreme accuracy of dimension... properties originally claimed for FC-101 and later confirmed in the performance of this outstanding refractory.

No wonder, then, that plants in over 20 countries, virtually girdling the globe, in addition to the United States and Canada—*over 150 in all*—are satisfied users of FC-101.

Look to FC-101 to demonstrate these qualities in *your* operation. Wire, write or phone for chemical analysis, complete technical data and other particulars.

WALSH REFRACTORIES CORPORATION — America's Best Clays

WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

FOR OVER 60 YEARS THE GLASS INDUSTRY'S PARTNER IN PROGRESS

NEWS
IN THE GLASS INDUSTRY

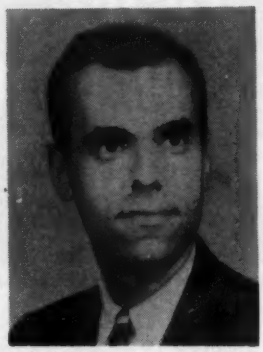
Robert A. James

Pittsburgh Plate Glass Co.

ROBERT A. JAMES, formerly plant manager, Clarksburg, W.Va., made assistant to the general manager of window glass plants, effective December 11, with headquarters in Pittsburgh, Pa. He succeeds H. J. BOKENKAMP, who has been named to the window glass planning and scheduling study group . . . RICHARD F. SPERRING, previously assistant plant manager, Crystal City, Mo., named manager, succeeding James . . . JOHN H. YEAMANS, tank department superintendent at Crystal City, now assistant manager, succeeding Sperring . . . HARRY A. SMITH, JR., grinding and polishing department superintendent at Cumberland, Md., now production superintendent . . . Four new market managing positions have been created in PPG's merchandising division: J. W. GERMAN, commercial construction, F. C. PAFFARD, JR., automotive replacement glass, R. D. SPENCER, residential construction, and JOSEPH STERN, industrial and specialty glass . . . In the chemical division, H. RICHARD SHERBURNE made district manager of the Los Angeles sales office, and ARTHUR W. WILSON, of the Portland, Ore., office . . . DONALD A. HUFF appointed district manager, San Francisco, succeeding O. W. ANDREWS, now director of marketing services with headquaters in Pittsburgh, Pa.

Libbey-Owens-Ford Glass Co.

F. E. SCHWERTFEGER, manager of Parallel-O-Plate manufacture, has been named manager of plate glass manufacturing in the newly-created eastern production division (including Rossford plate, East Toledo plate, and East Toledo laminating plants). He will continue with his over-all company responsibility as production manager . . . HENRY M. DODGE, manager of East Toledo plate and laminating plants, made manager of plate glass manufacturing in the newly-created western production division (including Ottawa, Ill., plate and laminating plants and Lathrop, Calif., fabricating plant now under construction) . . . HENRY SCHULT, first assistant to Dodge at East Toledo, succeeds him as manager for the two plants there . . . CHARLES A. MILLER, JR., second assistant, and ALBERT W. KLEINE,



Richard F. Sperring

production manager, both at East Toledo, become assistant plant managers for the two facilities.

Oswald Refractories Co.

RICHARD E. OSWALD elected a vice-president of the firm. He is also vice-president and sales manager for Alsey Refractories Co., Alsey, Ill.

Kimble Glass Co.

BERNARD L. STEIERMAN, new products manager for the electronic products division, with responsibility for new product development, product planning, and marketing analysis for electronic products.

American-St. Gobain Corp.

R. L. KEPLINGER, JR., product manager for rolled glasses and special products . . . J. S. MECKEL, formerly special products sales representative, now assistant product manager, rolled glasses and special products . . . R. K. LAURIN, manager, sales planning . . . A. M. ACKER, new division manager in field sales in Detroit, B. J. SHAFFER in Chicago, and J. M. KURTZ in New York . . . C. A. VAN WINKLE and A. E. FROMME, sales office managers in Los Angeles and San Francisco, respectively.

E. I. du Pont de Nemours Co.

RALPH C. NESTER, supervisor of glass shop at the company's experimental station in Wilmington, Del., retired in September after 33 years with Du Pont's central research department. Among his inventions is the spinning band; he has also developed improved diffusion pumps, manometers, stirring devices, seals, a field emission tube, and a wide variety of gas-discharge tubes.

Bausch & Lomb Inc.

DR. N. J. KREIDL, director of materials research and development, has been elected president of the Rochester Chapter of Sigma Xi, a scientific fraternity in the United States. Kreidl has also been elected chairman of the 1963 Gordon Conferences on Glass. He served as vice-chairman of the Conferences in 1961. Upon recommendation of the American Ceramic Society, and with approval of the National Academy of Sciences, his term as a member of Panel 09, advisory to the Bureau of Standards, has been extended to June 30, 1963.

Franklin Institute Offers Industrial Service

ALEC PETERS has been named to head the Scientific Information Service (SIS) set up by the Institute's technical library to help industry and scientific institutions implement research and development projects. The service offers literature searches in any area of mathematics, engineering, physics, chemistry, and industrial processing, and includes *(1)* bibliographic compilations, *(2)* annotated bibliographies, *(3)* abstracts of articles on a regular basis, *(4)* current literature monitoring on any subject, and *(5)* translations.

Colorado Fuel & Iron Corp.

EDWIN F. LORD, product sales manager, wire department, Wickwire Spencer Steel Div. He succeeds R. M. WAGNER, who continues as product sales manager, pig iron and semifinished steel department.

Corning Glass Works

RAYMOND A. WASSON named manager of Radome department, with responsibility for engineering, production, and sales of missile radomes in the technical products division . . . BILL B. KINTER, marketing specialist, will assist in introducing special new products normally sold through distributors . . . GEORGE A. KING made chief structural engineer in the manufacturing services division . . .VERNON J. PATTERSON appointed chief maintenance engineer . . . HARRY H. MARTS named manager of specialized products . . . F. WILLIAM GILLEN made plant manager at Danville, Ky., succeeding Marts . . . J. W. FISKE succeeds Gillen as controller, electrical products division . . . A 120,000-sq.-ft. electronic components plant at Raleigh, N. C., is expected to be in operation by summer of 1962. The single-story facility will produce fixed glass dielectric capacitors, including those for the Minutemen missile.

Perkin-Elmer Corp.

A new facility for manufacturing crystalline $CaCO_3$ (calcite) optics has been established by the firm at Norwalk, Conn., to meet the need for high-quality polarizing optics.

Emhart Manufacturng Co.

A. SEABURY CRANDON, JR., administrative engineer for the Hartford division. He was previously with American-St. Gobain Corp.'s Pittsburgh facility, specializing in technical phases of flat glass manufacturing.

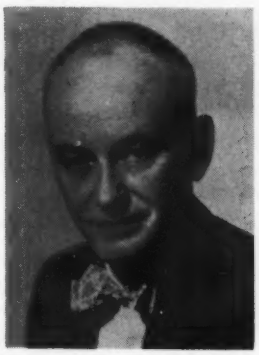
A. Seabury Crandon, Jr.

American Society for Testing Materials

ASTM has officially changed its name to American Society for Testing *and* Materials. According to president Miles N. Clair, the inclusion of the word "and" adds emphasis to the organization's research work in the field of materials. ASTM now has almost 11,000 members, including individuals, companies, government agencies, and educational institutions. In addition, about 7,000 prominent engineers and scientists serve as representatives of company members on the society's technical committees.

Brockway Glass Co.

FINDLEY B. HESS, president, has become a director of Consumers Glass Co. Ltd., of Montreal and Toronto, under the provision of an agreement between the two companies to exchange technical information.



Howard Strandberg

H. K. Porter Co.

HOWARD STRANDBERG named assistant general sales manager, refractories division. He was previously the division's New York district sales manager.

Dr. Ralph K. Day Returns to Consulting Field

After rejoining the Libbey-Owens Ford Glass Co. research department in 1959, Dr. Day has returned to the consulting field. He has set up a laboratory at 307 West Harrison Ave., Maumee, O., in which he will measure thermal conductivity of dense ceramics. For the past 2 years, Day has worked on the evaporation of thin films in high vacuum, with some interesting new techniques of evaporation from beryllia crucibles at very high temperatures and improved control over oxidation-reduction conditions resulting.

Selas Corp.

W. RODERIC BLISS, assistant director of research. He was formerly with the Martin Co., Baltimore, as manager of industrial development on the corporate planning staff.

W. Roderic Bliss

International Glass Commission

DR. OSCAR BURCH, vice-president and director of research and development for Owens-Illinois Glass Co., elected to complete the term of the commission's late president, HOWARD R. LILLIE, at the 12th annual meeting in Florence, Italy.

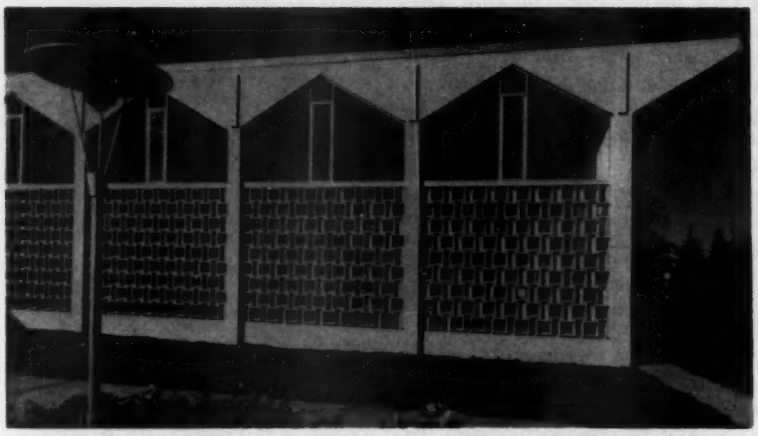
Chemical Sales To Reach New High

Speaking before the National Industrial Conference Board in New York recently, Chris F. Bingham, vice-president of chemical sales for the Pittsburgh Plate Glass Co., chemical division, predicted that chemical industry sales will amount to more than $30 billion in 1962. Sales for 1960, he reported, were $27.7 billion, and estimates for 1961 exceed $29 billion.

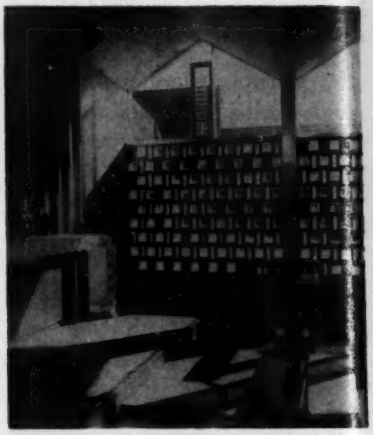
Synthetic Diamonds Being Produced

Ultra High Pressure Units Ltd., a company associated with De Beers Consolidated Mines, Ltd., will begin production of synthetic diamonds for industrial uses. The decision to build a plant for the commercial manufacture of synthetic diamonds was made in 1960 when diamond mining operations in the Congo were interrupted briefly. While natural diamond is desirable for most industrial applications and stocks are presently ample, the availability of synthetic diamond grit will prevent any future break in supplies to the market. De Beers announced the perfection of a method for producing synthetic diamonds in 1959.

NEW APPLICATIONS IN GLASS...



Glass blocks, with translucent ceramic color fired on, are shown in exterior view.



Colored blocks transmit light to chapel interior.

Glass Blocks Transform Solar Screen into Wall

By filling what would ordinarily be sun screen openings with a combination of 8-in., square clear glass blocks and 4- by 12-in. rectangular colored glass blocks, architects have transformed the popular solar screen into a rugged and colorful wall. The 4-in. thick blocks have a partial vacuum in their interior which gives them the insulation equivalent of a 12-in. masonry wall. Cost for construction of such a wall, *e.g.* St. Gabriel's Hospital Chapel, Little Falls, Minn., is less than $6 per square foot. *Pittsburgh Corning Corp.*

Reader Service Card: Circle No. 53

Lightweight Mirrors for High-Precision Optics

A new type of mirror construction—a honeycomb cross section—achieves weight savings without sacrificing rigidity or stability in high-precision optical elements. Designed for air-borne optical systems and other systems requiring low-inertia components, these mirrors have a base of honeycombed fused quartz to which a thin layer of solid fused quartz is attached. Spherical, aspherical, or flat reflecting surfaces are furnished. *Precision Lapping Co.*

Reader Service Card: Circle No. 54

Improved Incandescent Lighting

A glass said to correct the color balance of incandescent lamps is also credited with eliminating virtually all heat-producing infrared energy radiated by the light source. Designed for surgical and dental applications where coolness and true color perceptioin are essential, the "Blue Aklo" filtering glass can be used in photoengraving, photographic, theatrical, movie, and television lighting systems. *Corning Glass Works.*

Reader Service Card: Circle No. 55

Glass Insulating Roof

Cellular glass insulation placed in bulb tee-irons serves as roof decking for cold storage freezers, eliminating the need for conventional precast concrete roof decking. This material, high in compressive strength, is also used as floor insulation, at the same time supporting the building columns. Recently put into operation by the Commercial Cold Storage Co., Atlanta, Ga., this technique allows the construction of a complete "envelope" of insulation around the refrigerating enclosure. *Pittsburgh Corning Corp.*

Reader Service Card: Circle No. 56

CATALOGS RECEIVED

Curtain and window walls (16 pages). Illustrates various types of curtain walls. window walls, and interior division walls for office buldings. schools, hospitals, apartments, hotels, and commercial and industrial buildings. Typical specifications are included. *W. P. Fuller & Co.*

Reader Service Card: Circle No. 57

Laboratory glassware (294 pages). Catalog SP-75 lists over 3000 items, many of them new, some exclusive. Included are Erlenmeyer flasks, petri dishes, beakers, and a wide variety of other laboratory articles. Prices are given. *Kimble Glass Co.*

Reader Service Card: Circle No. 58

Glass-protected chemical process equipment (8 pages). This booklet supplies basic information on reactor capacities, dimensions, pressures, and approximate tank jacket weights. Glass-lined pipe and fittings, columns, heat-exchanger tubes, receivers, and condensers are also featured. *Glascote Products, Inc.*

Reader Service Card: Circle No. 59

Laminated architectural glass (4 pages). Describes industrial applications for glass which remains intact when subjected to repeated low-pressure shocks or low-energy missiles and minimizes the hazards of flying glass. Can be produced in standard sizes and cut to size in the field. Will fail at lower pressures than typical building frames and walls, thus protecting against building collapse. *Monsanto Chemical Co.*

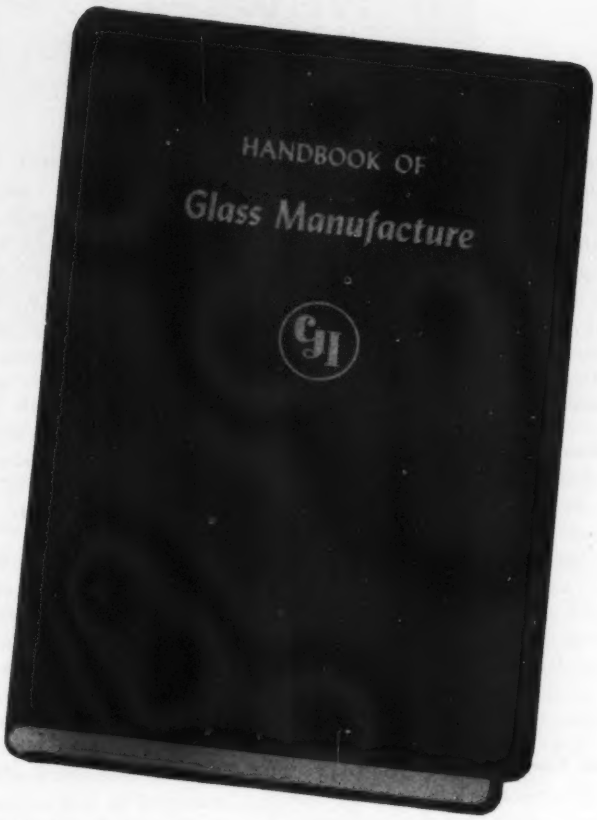
Reader Service Card: Circle No. 60

Mirrors for home and office (24 pages). Catalog is indexed in special decor sections and settings for the home are suggested. *Thompson Glass & Paint Co., Mirror Div.*

Reader Service Card: Circle No. 61

HANDBOOK OF GLASS MANUFACTURE

3rd Printing BY DEMAND



VOLUME I A valuable reference for the glass man, containing basic material on . . . CHEMICAL MAKEUP OF GLASS . . . PHYSICAL PROPERTIES (brittleness, resiliency, hardness, thermal expansion, etc.) . . . RAW MATERIALS . . . BATCH MATERIALS HANDLING AND PREPARATION . . . FURNACES AND FUELS (fuel and combustion data and calculations; fuel economics, heat losses, draft and chimneys; glass-melting furnaces) . . . INSTRUMENTATION (temperature, pressure, flow, level, and speed control; forming operations; lehrs) . . . REFRACTORIES . . . GLASS PREPARATION (types of reaction; melting, fining, homogenizing; detection of cords; density, etc.) . . . FEEDING AND FORMING (gob feeder; blow-and-blow, IS, press-and-blow, paste mold, and bulb machines; hand processes; forming defects; viscosity; bottle shape, design, and weight) . . . ANNEALING AND TEMPERING (release and strain; annealing equations; annealing of plate glass, optical glass, and pressed and blown ware; special problems in tempering flat glass) . . . GLASS DECORATING.

VOLUME II First Printing (Published in 1960)

Order your copies of Volume I and Volume II NOW.

OGDEN PUBLISHING COMPANY
55 West 42nd St.
New York 36, N.Y.

Please send me The Handbook of Glass Manufacture

_____copy(ies) Volume I (506 pages) $15.00* per copy

_____copy(ies) Volume II (276 pages) $10.00* per copy

*Shipping and handling charges: 60¢ per copy (domestic)
90¢ per copy (foreign)

Foreign remittance in U. S. Dollars.

(Order for 5 or more copies, 10% discount).

Amount enclosed $_____.

Name _____

Company _____

Street _____ City _____ State _____

CONTENTS . . .

OPTICAL PROPERTIES
N. J. Kreidl, *Bausch & Lomb Incorporated*

EFFECTS OF HIGH ENERGY RADIATION
N. J. Kreidl, *Bausch & Lomb Incorporated*

CHEMICAL ANALYSIS OF GLASS
Frances W. Glaze, Consultant
John Tims, *Owens-Corning Fiberglas Corp.*

THE QUALITY CONTROL CHART
Ronald Wiley*, *Owens-Corning Fiberglas Corp.*

SCIENTIFIC GLASSBLOWING: GLASS FABRICATION
Vincent DeMaria,† *Glass Products Development Laboratory*

GLASS COMPOSITION, DEVITRIFICATION AND STRUCTURE
Fay V. Tooley, *University of Illinois*

FLAT GLASS MANUFACTURING PROCESS
Roy G. Ehman, *Pennsylvania State University*

ELECTRIC MELTING OF GLASS
Larry Pemberthy, *Penberthy Electromelt Co.*

*Now with Deering Milliken Research Corp.
†Now with Thermal America Fused Quartz Co.

Both volumes have been edited by Fay V. Tooley, professor of glass technology, University of Illinois. Every chapter has been written by an authority in the field. These detailed reference books have an important place in the laboratory and on the desk of every glass man. They are basic, authoritative, comprehensive.

NEW EQUIPMENT AND SUPPLIES

Glass Handworking Tool

Called the "Spandle", this tool is designed for repairing glass apparatus, modifying glass systems, and making simple glass articles. The device enables the novice to make straight seals, ring seals, T's and Y's, and has a chucking capacity ranging from 3 to 50 mm. *Bethlehem Apparatus Co.*

Reader Service Card: Circle No. 62

Glass Annealing Ovens

Said to fire evenly and accurately without the use of a blower system or other outside appliances. Can also be used for bake-out work and in conjunction with an outside vacuum pump. All models equipped with 5-hour timers and insulated with high-quality refractory brick. Minimal maintenance is claimed. *W. E. Mushet Co.*

Reader Service Card: Circle No. 63

New Conveying System

A "progressing cavity" pump replaces blowers, ducts, and dust collectors in conveyor capable of performance up to 24,000 lb. per hour. The principle is similar to that of a precision screw conveyor and has been tested for 2 years on various dry powders, including clays, calcium carbonate, silica, talcum, and certain resins. Totally enclosed, the system is said to insure neater, more efficient conveyance, and can be installed at half the cost of comparable pneumatic systems. *Moyno Pump Div., Robbins & Myers, Inc.*

Reader Service Card: Circle No. 64

Bronze Take-Out Tongs

New line of tongs is available in bronze with steel shank, or in all bronze with steel cap. Seventeen different models are designed for use with IS single- and double-gob machines. Fabricated from wrought bronze rather than from bronze castings, these tongs provide greater structural strength and reduce checking of the bottle neck. They are supplied completely finished, ready to be bored for neck size of the bottle. *Garvey Products Corp.*

Reader Service Card: Circle No. 65

Automatic Check Inspector

Inspects the finishes of round, wide-mouth glass jars of the lug, thread, pry-off, or twist-off type. Operates at speeds of up to 100 jars per minute. The "Type 127, Model E" machine indexes jars at the inspection station and rotates them while they are being checked photoelectrically. Two units, combined to form a dual installation, are said to be capable of accurately inspecting the output of a 6-section IS machine operating double-gob. The machine can accommodate jars ranging from 2 to 4 in. in diameter and 2½ to 8¾ in. in height. *Emhart Mfg. Co.*

Reader Service Card: Circle No. 66

High-Efficiency Air Blower

Available in pressure ranges from 6 to 20 oz. with motors up to 30 hp. Designed primarily for combustion system applications, the blower is cased in welded steel which provides a smooth surface with minimum friction for air flow. Capability ranges from 100 to 5300 cfm, and the impeller can either be mounted directly on the motor shaft or belt-driven. *Pyronics, Inc.*

Reader Service Card: Circle No. 67

Annealing Attachment for Hot-Cut Operations

Automatically anneals cut and flared glass tubing at a rate of 2400 pieces per hour. Specially designed for use with high-speed automatic hot-cut machines. *Kahle Engineering Co.*

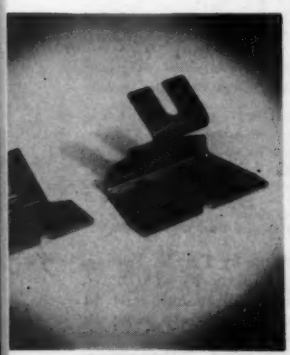
Reader Service Card: Circle No. 68

Circular Conveyors

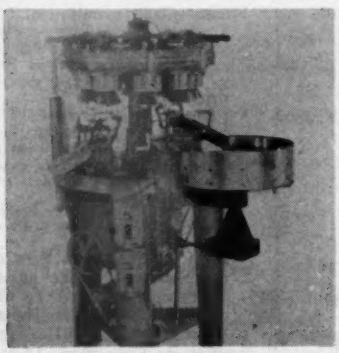
Noiseless operation and maximum safety of articles transported are two of the major advantages claimed for these conveyors and wire mesh belts now being produced for use in the glass industry. Forming a bridge between two straight conveyors placed opposite each other, the circular conveyor creates a curve ranging up to 360°. Because there is practically no void on either side, transition takes place smoothly, without any bumps or jerks.

The belt consists of bars formed into a conic whole by means of flat wire spirals. Top of the belt is completely flat, and bands of material on the supporting and vertical guide strips reduce resistance to a minimum. Belt widths range up to 5 ft. Maximum speed of conveyor is 120 ft. per minute. *N. V. Draadindustrie Jonge.*

Reader Service Card: Circle No. 69

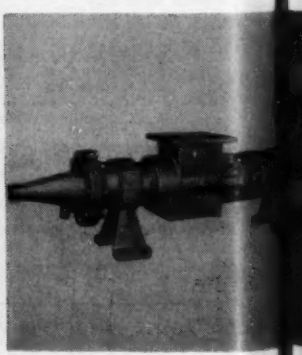


Garvey take-out tongs . . .



. . . Kahle annealing attachment . . .

. . . Emhart check inspector . . .



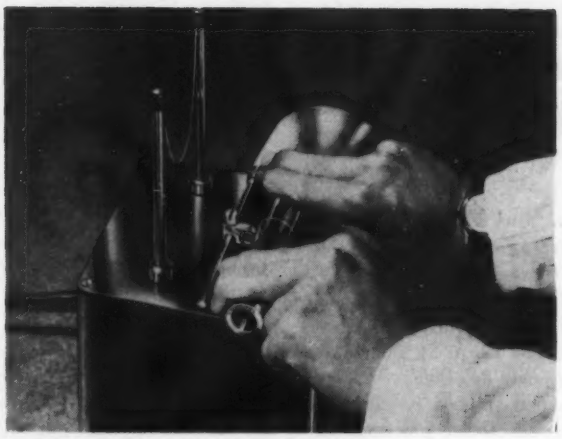
. . . new Moyno pump . . .

Simple, Effective Glass Cutter

Thick- or thin-walled glass tubes up to 3 in. in diameter can be cut quickly and cleanly with this new British device. Also suitable for use on glass rods, the apparatus consists of a scribing diamond and a length of nickel-chrome wire connected between two terminals.

A scratch is produced around the circumference of the glass by rotating the tube or rod against the cutting diamond, which is screw-mounted to adjust to the length of the glass being cut. Power is supplied to the wire loop, and when the scratch on the glass is brought in contact with the hot wire, the sharp temperature rise causes the glass to crack along the line of the scratch. The cutter is also effective on heat resistant glass. *Electrothermal Engineering Ltd.*

Reader Service Card: Circle No. 70



British device for cutting glass tubing in laboratory or workshop.

Three-Way Conveyor Switch

Flexible roller curve units have been introduced for switching conveyorized items onto spur lines to the left, right, or straight ahead. Models are also available for "Y" switching. Units can be connected to gravity or power conveyors, and operated by hand or by motor from remote locations. Twelve-, 18-, and 24-in. conveyors can be accommodated. *Rapids-Standard Co., Inc.*

Reader Service Card: Circle No. 71

Small- and Medium-Capacity Infrared Heaters

Gas-fired infrared heaters are designed for annealing glass vials and glass cigar tubes, and for use in the preheating and cooling-off zones in glass bottle annealing ovens. Outputs range from 2300 to 16,000 Btu per hour. Burners may be operated on natural or LP gas, and the units are shipped for atmospheric use or prepared for premixed fuels. *Fannon Products Div., Hupp Corp.*

Reader Service Card: Circle No. 72

Spotting-In Glass Molds

Spotting-in time can be increased 70 per cent with the use of an elevating bed and lower platen which ride on four 4-in. diameter guide bars. The crown is stationary. Die halves are secured to movable platens, and roll from the crown and bed on hardened steel ball bearing rollers to tilting position. Up to 130 psi can be applied. *Sanders Tool & Production Co.*

Reader Service Card: Circle No. 73

CATALOGS RECEIVED

Glass-tinting compound (4 pages). Gives uses and specifications of "Sun-X", distributed by Sun-X International, Inc. Shows how the product can be applied to existing glass areas and to what extent it reduces heat transmission, fading, and glare in homes and commercial buildings. *E. I. du Pont de Nemours & Co.*

Reader Service Card: Circle No. 74

Temperature-controlled equipment (64 pages). Illustrated booklet covers complete line of electric ovens, furnaces, magni-whirl baths, and environmental cabinets for the laboratory, pilot plant, and production. Sizes, temperature ranges, voltages, and capacities are given. *Blue M Electric Co.*

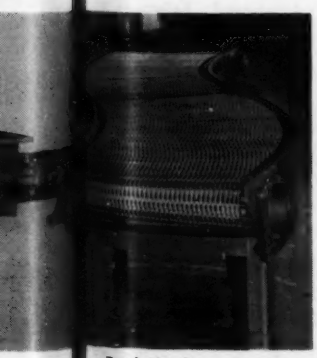
Reader Service Card: Circle No. 75

Cemented diamond particles (12 pages). Diamond dressing tools catalog No. 861 describes this new concept in diamond tool engineering design. Lists specifications, applications, and advantages for five different models. *Koebel Diamond Tool Co.*

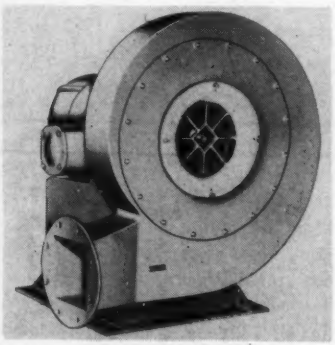
Reader Service Card: Circle No. 76

Abrasion test for refractory brick and monoliths (8 pages). This test uses impingment of a stream of air-entrained silicon carbide grit to determine the resistance of specimens. Text, photos, tabulations, and charts give complete details on test techniques, equipment, and results. *Harbison-Walker Refractories Co.*

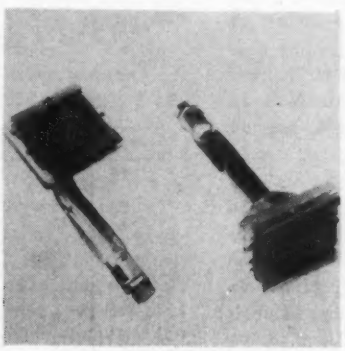
Reader Service Card: Circle No. 77



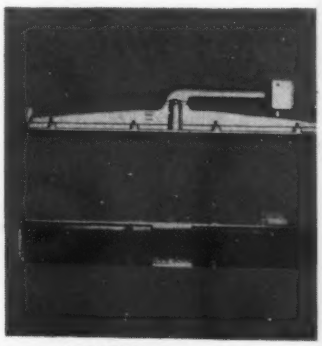
. . . Dutch circular conveyor . . .



. . . Pyronics air blower . . .



. . . Fannon 2300-Btu heaters . . .



. . . and 15,350-Btu heaters.

INVENTIONS AND INVENTORS

Glass Wool and Fibers

Silicon-Containing Azo Triazine Dyes for Dyeing Glass Fibers. Patent No. 2,963,338. Filed Aug. 25, 1959. Issued Dec. 6, 1960. No drawings. Assigned to Union Carbide Corp. by Donald L. Bailey and Ronald M. Pike.

This invention relates to organosilicon compounds and to processes for their production. More particularly, this invention is concerned with organosilicon compounds containing, among other functional groups, an iminoalkylsilyl group [—NH$(CH_2)_a$Si≡] and an iminoazo dyestuff group (—NHArN=N—) attached to a carbon atom of the triazine ring through the nitrogen atom of the imino group, as new compositions of matter.

A dye bath was prepared consisting of one gram of 2-chloro-4-gamma-triethoxysilylpropylimino-6-4(4′-p-tolylazo-2′-methylphenylimino)-triazine in 50 ml of methanol and 2 ml of pyridine. The dyebath was a turbid suspension with only slight solubility of the dyestuff in the solvent. A test fabric, consisting of woven strips of glass cloth was added. The sample was removed at the end of the test period, washed with water, and dried. The samples were all dyed a yellow to yellow-orange shade. The dyeing can also be carried out from an aqueous dyebath at elevated temperatures, at about 95°C, in about one hour.

There were 15 claims and the following references cited in this patent.

United States Patents

1,958,327, Winkler, May 8, 1934; 2,436,304, Johannson, February 17, 1948; 2,715,133, Speier, August 9, 1955.

Other References

Journal Organic Chemistry, Vol. 18, January 1953, pages 47, 48, and 54.

Feeding and Forming

Method of Producing Color-Controlled Vitreous Materials. Patent No. 2,979,-865. Filed February 27, 1958. Issued April 18, 1961. One drawing; not reproduced. Assigned to Owens-Illinois Glass Co. by Robert R. Rough.

The invention is particularly applicable to the automatic manufacture of various color-controlled glasses produced within tank furnaces. The process involves installing a color moderating element within a wall of the glass retaining receptacle and causing the batch of molten glass to flow past the moderating apparatus in contact with the element to effect the color-controlling operation. The decoloring or coloring agent may be added to the glass either within the melting chamber, the refiner, or the forehearth, one region of which is employed as a distributing area to render the mixture of molten batch and color-controlling medium homogenous. A homogeneous continuous stream of color-controlled glass is produced in the downstream area immediately adjacent to where the color-controlling agent is introduced.

The color-controlling medium consists preferably of selenium in the form of metal or selenates or selenites, although other color-controlling agents may also be suitably employed. When the valence of selenium introduced into the glass is 0 (zero), a slightly pink color is imparted to the glass. When the selenium has a valence of +2, +4 or +6, it serves to exert a decoloring action on the molten glass. At this time brownish or bluish colorations in the glass are either neutralized or destroyed to the extent that the glass then becomes decolored, completely transparent, or completely neutral. The color-controlling element is essentially one which is soluble in molten silicates and may also be fabricated of powdered glass containing a rather high proportion of the color-controlling medium.

There were 2 claims and 11 references.

Glass Compositions

Optical Glass. Patent No. 2,967,779. Filed March 24, 1958 (Claims priority; application Japan, November 20, 1957). Issued January 10, 1961. No drawings. Assigned to the Director of the Agency of Industrial Science and Technology, the Ministry of International Trade and Industry, Japanese Government, by Tetsuro Izumitani.

The invention relates to improved optical glass, and particularly to cadmium-lanthanum-borate glass having a high refractive index and a moderate Abbe value. The latter is unstable and has a tendency to devitrify during manufacture of the glass itself. The melt fails to vitrify when the boric oxide present is confined to no more than 24 weight per cent. This inventor, however, has found that the devitrification tendency may be eliminated on an industrial basis, without reducing the refractive index, by employing titanium oxide and/or tungsten oxide in addition to silicon dioxide and zirconium oxide when such components are added to a glass consisting of 18 to 23 per cent by weight of boric oxide, and less than 90 per cent by weight of the oxides of cadmium, lanthanum, and boron taken together. Table I gives preferred embodiments or examples of this invention.

There were three claims and the following references.

United States Patents

2,430,540, Sun *et al.*, November 11, 1947; 2,434,149, De Paolis, January 6, 1948; 2,523,362, Fraser, September 26, 1950; 2,584,975, Armistead, February 12, 1952, and 2,678,281, Geffcken *et al.*, May 11, 1954.

TABLE I—Components in Weight Per Cent

Example	B_2O_3	CdO	La_2O_3	SiO_2	ZrO_2	TiO_2	WO_3	Ta_2O_5	N_D	V
1	23	30	30	5	4	6	2	—	1.8237	37.3
2	23	36	27	5	4	2	3	—	1.8011	40.6
3	23	28	34	5	4	2	4	—	1.8078	41.0
4	23	32	29	5	4	—	4	3	1.7928	42.7
5	23	29	28	5	4	—	4	7	1.7942	42.2
6	22	36	27	5	4	6	—	—	1.8300	36.8
7	20	45	20	5	4	6	—	—	1.8403	35.1
8	18	33	30	5	4	6	4	—	1.8585	34.9
9	18	43	20	5	4	6	4	—	1.8548	33.7

Treatment of Glass Batch. Patent No. 2,975,555. Filed October 6, 1958. Issued March 21, 1961. One sheet of drawings; not reproduced. Assigned to Libbey-Owens-Ford Glass Co. by James T. Zellers, Jr., Alfred E. Badger, and Glen J. Lehr.

This invention relates broadly to the charging of batch into a glass melting tank, and more particularly to an improved method of decreasing the batch dust carry-over into the checkers of a regenerative or recuperative type of glass melting furnace.

It has been found that if water or a solution of a material having a tendency to react with the batch is sprayed over the top of the blanket before it enters the furnace this material would dry and react with the batch to form a cover or crust over the batch before it actually entered the furnace firing chamber. Thus the loss of batch material to the checkers would be decreased, if not entirely eliminated.

Assuming that the impregnating solution is sodium silicate and that the batch blanket is 10 in. deep, a surface treatment by the sodium silicate solution to about ½ in. in depth would be sufficient. Only about 1/20 of the batch blanket would therefore be treated, and the effect upon the composition of the glass would be negligible. For example, the treatment of the total amount of batch with sodium silicate would change the chemical composition of the glass by about 0.35 per cent Na_2O and nearly 1 per cent SiO_2. Such changes in the glass composition would require compensating changes in the glass batch. However, by treating only the upper ½ in. of a 10-in. thick blanket with sodium silicate, the glass composition would be changed by only about 0.02 per cent Na_2O and 0.07 per cent SiO_2.

Both of these increases are negligible in commercial practice, and no compensation in batch composition would be necessary. The chemical composition of the sodium silicate is not critical. However, sodium silicate having a specific gravity of 47°Be and a nominal composition of 11 per cent Na_2O and 13.2 per cent SiO_2 is satisfactory. It has been found that diluting this sodium silicate with an equal volume of water provides a solution which is satisfactory for spraying. An estimated amount of 40 gal. of sodium silicate per day is sufficient for treating the batch blanket.

There were four claims and the following references.

United States Patents

708,309, Bronn, September 2, 1902; 1,623,057, Kingsley, April 5, 1927; 2,294,373, Batchell, September 1, 1942; 2,498,766, Pettigrew, February 28, 1950.

Tube and Cane Machines

Apparatus and Method for Producing Glass Tubing. Patent No. 2,979,864. Filed May 21, 1957. Issued April 18, 1961. Two sheets of drawings; none reproduced. Assigned to Kimble Glass Co. by Alfred D. Pinotti.

This invention relates to improvements in both apparatus and method for producing glass tubing by the Danner process. Where certain types of glass are being used, borosilicate, for example, it has been discovered that there is substantial surface volatilization of boron and alkali-metal constituents from the glass, which results in an exposed silica-rich surface on the formed glass tube. The loss of these more volatile components produces incipient devitrification, which manifests itself as a visible "surface smear."

The general object of this invention is to overcome this deficiency, as well as other deficiencies resulting from volatilization losses. To that end, an alkali metal and boron-containing compound is introduced into the tube-forming chamber or muffle in such amounts as to cause the atmosphere surrounding the glass supply stream and initially-formed glass on the mandrel to become saturated with boron and alkali metal oxides. Consequently, this saturated atmosphere prevents, or, in any event, materially reduces loss of the identified components at the glass surface, thereby eliminating the defects described here.

The added material may be composed of borax ($Na_2B_4O_7.10H_2O$), kernite ($Na_2B_4O_7.4H_2O$), or "Pyrobor" ($Na_2B_4O_7$). When these materials are heated within 1200°C to 1575°C by electrical elements, boron and sodium oxide are evolved in the vaporous state. The vapors are moved upward by convection and draft currents to create the boron and metal oxide containing atmosphere. Thus, the atmosphere is normally highly enriched or saturated with these components. Other materials such as salt (NaCl) or salt cake (Na_2SO_4) may be similarly volatilized to produce other desired components in the forming atmosphere, preventing their loss from the glass.

There were ten claims and the following references.

United States Patents

1,219,709, Danner, March 20, 1917; 2,038,691, Taylor, April 28, 1936; 2,065,852, Dalton, December 29, 1936; 2,155,131, Hanlein, April 18, 1939; 2,433,116, Greenbowe *et al.*, Dec. 23, 1947, and 2,630,656, Kramer *et al.*, March 10, 1953.

Foreign Patents

849,843, France, December 2, 1939.

Glass Wool and Fiber

Method and Apparatus for Forming Fibers. Patent No. 2,978,744. Filed September 9, 1955. Issued April 11, 1961. Six sheets of drawings; none reproduced. Assigned to Owens-Corning Fiberglas Corp. by Charles F. Schroeder.

This invention provides a method and apparatus for forming fine streams, elongated bodies, or primaries of fiber-forming mineral material. The material is extruded under regulated or controlled static pressure sufficient to project the streams or primaries in substantially horizontal paths. The streams or primaries are engaged by a gaseous attenuating blast moving in a direction substantially normal to the paths of the extruded streams or primaries to form them into fine fibers.

This invention also provides forehearth and feeder means maintained under pressure. A large number of minute streams or bodies of glass or other heat-softenable material may be projected at controlled flow rates from opposite directions into an attenuating blast, formed of burned gases of combustion, at temperatures well above the attenuating temperature of the glass. In this way, the streams or bodies are attenuated into fine fibers.

In addition, the invention provides a method and apparatus for forming fibers whereby a comparatively large number of pressure-extruded bodies of fiber-forming material are delivered into an attenuating blast. Here comparatively large quantities of fiber-forming material are converted to fine fibers with a minimum expenditude of attenuating energy.

There were 16 claims and 15 references.

(*Continued on page* 664)

CALENDAR
OF COMING EVENTS

November 27-December 1

28TH EXPOSITION OF CHEMICAL INDUSTRIES. New York Coliseum, New York, N. Y.

November 28-30

BUILDING RESEARCH INSTITUTE. 1961 Fall Conference. Mayflower Hotel, Washington, D. C.

November 30-December 1

22ND ANNUAL CONFERENCE ON GLASS PROBLEMS. Program will cover *(1)* flow in glass tanks, *(2)* solid-solid mixing as related to batch preparation, and *(3)* product and/or process control relating to control techniques and/or systems. For further information, contact F. V. Tooley, Professor of Glass Technology, 208 Ceramics Building, University of Illinois, Urbana, Ill.

January 22, 1962

ACS NORTHWESTERN OHIO SECTION. Annual Meeting, Symposium, and Toledo Award Banquet. Award will be presented to Henry H. Blau, Federal Glass Co. Symposium topic is heat transfer phenomena in glass and ceramics.

February 6-8, 1962

SPI 17TH REINFORCED PLASTICS DIVISION MEETING. Edgewater Beach Hotel, Chicago, Ill.

February 11-14, 1962

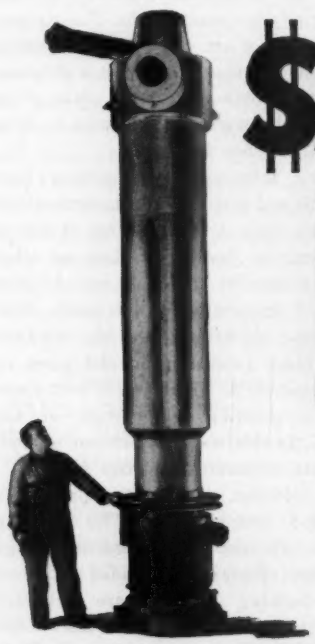
CANADIAN CERAMIC SOCIETY. Diamond Jubilee Meeting. Royal Connaught Hotel, Hamilton, Ontario, Canada.

March 14-17, 1962

OPTICAL SOCIETY OF AMERICA. Spring Meeting. Mayflower Hotel, Washington, D. C.

June 6-8, 1962

AMERICAN SCIENTIFIC GLASSBLOWERS SOCIETY. Seventh Annual Symposium and Exposition. Ralph H. Russler, chairman. Papers should be submitted to Wellman Clark, Chairman, Paper Committee, Naval Ordinance Lab., White Oaks, Silver Spring, Md. February 15, 1962, deadline for 1-page abstracts; March 30, 1962, deadline for manuscripts. Sheraton Park Hotel, Washington, D. C.



$AVE FUEL

INSTALL A METAL AUSTEEL-ESCHER RECUPERATOR

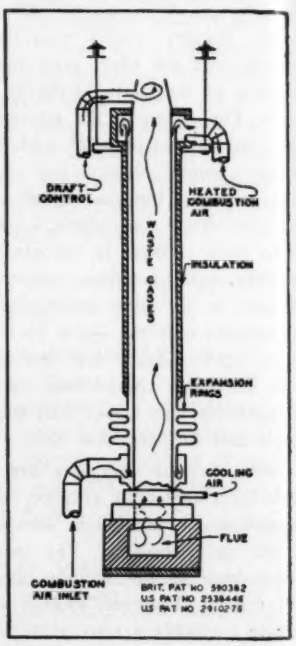
Fuel Savings of up to 43% have been encountered

- FOR GLASS MELTING FURNACES
- FOR CHEMICAL FURNACES

Individually designed for your particular requirements

★ Write us for particulars

One of a pair of single stage Recuperators ready for installation on a fiber glass furnace



Improved furnace operating conditions enable increased production

TOLEDO ENGINEERING Company INC.

PHONE GREENWOOD 5-1529

DESIGNERS AND BUILDERS OF GLASS MELTING FURNACES

3003 SYLVANIA AVENUE, TOLEDO 13, OHIO

STATISTICAL POSITION OF GLASS

Glass Container Shipments during August, 1961, came to 18,094,000 gross, an increase of 37.7 per cent over the July, 1961, figure of 13,135,000 gross. Shipments during August, 1960, amounted to 16,352,000 gross, or 9.6 per cent less than August, 1961. At the end of the first 8 months of 1961, shipments have reached a preliminary total of 112,261,000 gross. This is 5.5 per cent more than the 106,381,000 gross shipped during the same period of the previous year.

GLASS CONTAINER SHIPMENTS

(All Figures in Gross)

Wide Mouth Containers

Food	*5,456,000
Medicinal and Health Supplies	524,000
Chemical Household and Industrial	172,000
Toiletries and Cosmetics	372,000
Dairy Products	190,000
	* 6,714,000
Subtotal (Wide)	6,714,000
Total Domestic	*17,939,000
Export Shipments	155,000
TOTAL	*18,094,000

* This figure includes fruit jars, jelly glasses, and packers' tumblers.

Narrow Neck Containers

	August, 1961
Food	2,515,000
Medicinal and Health Supplies	1,898,000
Chemical, Household and Industrial	1,048,000
Toiletries and Cosmetics	1,147,000
Beverages	
Returnable	750,000
Nonreturnable	298,000
Beer	
Returnable	161,000
Nonreturnable	1,952,000
Liquor	1,014,000
Wine	442,000
Subtotal (Narrow)	11,225,000

GLASS CONTAINER PRODUCTION AND INVENTORY

(All Figures in Gross)

		Production August 1961	Stocks August 1961
Food, Medicinal and Health Supplies; Chemical, Household and Industrial; Toiletries and Cosmetics, Beverages	Narrow Neck	5,909,000	7,380,000
	Wide Mouth	*6,134,000	7,091,000
Returnable		538,000	2,066,000
Nonreturnable		253,000	670,000
Beer			
Returnable		133,000	483,000
Nonreturnable		1,897,000	1,155,000
Liquor		1,105,000	1,676,000
Wine		405,000	788,000
Dairy Products		147,000	220,000
TOTAL		*16,521,000	*21,529,000

* This figure includes fruit jars, jelly glasses, and packers' tumblers.

Glass Container Production based on figures released by the Bureau of Census, Industry Division, was 16,521,000 gross during August, 1961. This is an increase of 12.8 per cent over the previous month's production figure of 14,644,000 gross. During August, 1960, glass container production was 15,710,000 gross, or 4.9 per cent less than the August, 1961, figure. At the end of the first 8 months of 1961, glass manufacturers have produced a preliminary total of 114,051,000 gross. This is 2.9 per cent more than the 110,771,000 gross produced during the same period in 1960.

Stocks on Hand at the end of August, 1961, came to 21,529,000 gross. This is 6.6 per cent less than the 23,070,000 gross on hand at the end of July, 1961, and 0.1 per cent less than the 21,570,000 gross on hand at the end of August, 1960.

Employment in the glass industry during July 1961 was as follows. *Flat Glass*: a preliminary figure of 24,000 for July 1961, indicates an increase of 4.7 per cent over the figure of 23,100 given for June, 1961. *Glass and Glassware, Pressed and Blown:* an increase of 0.1 per cent is shown by the preliminary figure of 89,100 reported for July, 1961, when compared with the adjusted figure of 89,000 reported for June, 1961. *Glass Products Made of Purchased Glass:* The preliminary figure of 13,100 given for July, 1961, is 2.3 per cent over the figure of 12,800 reported for June, 1961.

Payrolls in the glass industry during July, 1961, were as follows. *Flat Glass*: an increase of 3.1 per cent is shown by the preliminary figure of $13,141,928.34 given for July, 1961, when compared with the adjusted figure of $12,736,652.88 given for June, 1961. *Glass and Glassware, Pressed and Blown:* a decrease of 1.04 per cent is shown in the preliminary $36,846,549.43 given for July, 1961, when compared with the previous month's adjusted figure of $37,237,108.72. *Glass Products Made of Purchased Glass:* a preliminary figure of $4,272,498.32 was reported for July, 1961. This is a decrease of 1.7 per cent when compared with the adjusted figure of $4,347,264.24 for June 1961.

Pressed and Blown Glassware Imports for the first half of 1961 showed a gain of only 0.2 per cent over the corresponding period in 1960. Imports totaled $10,573,813 at the end of June, 1961, as compared to the 1960 figure of $10,554,655. Total imports from all major countries except Japan registered declined during this period. West Germany remained in first place as principal supplier to the United States of pressed and blown glassware, and imports from Sweden showed the greatest dollar decline. Imports of technical, scientific, and industrial glassware and machine-made glassware showed gains for the first 6 months of 1961.

IMPORTS OF PRESSED AND BLOWN GLASSWARE BY PRINCIPAL COUNTRY OF ORIGIN*

(First 6 Months)

	1960	1961
Sweden	$ 671,743	$ 513,912
West Germany	2,978,632	2,930,704
United Kingdom	542,975	494,770
Italy	1,817,707	1,685,780
Japan	1,811,208	2,084,356
France	531,227	483,988
Other†	2,201,163	2,380,303
TOTAL	$10,554,655	$10,573,813

* Consumer Durables Division, Business and Defense Services Administration.
† This figure includes imports of machine-made glass from Hong Kong in the amount of $104,672.

IMPORTS OF PRESSED AND BLOWN GLASSWARE BY TYPE*

(First 6 Months)

Country	Tumblers, Stemware, Table Kitchen, Cooking, and Art Ware: Machine Made	Tumblers, Stemware, Table Kitchen, Cooking, and Art Ware: Hand Made	Illuminating and Electronic Ware	Technical, Scientific, Industrial, and Other	Tot
Sweden	1,051	431,710	69,370	11,781	513,912
West Germany	11,396	1,200,184	798,187	920,937	2,930,704
United Kingdom	4	157,940	26,389	310,437	494,770
Italy	5,220	1,171,893	226,098	282,569	1,685,780
Japan	1,232	426,905	360,778	1,295,441	2,084,356
France	54,551	213,207	116,380	99,850	483,988
Other	117,882†	1,364,724	369,772	527,925	2,380,303
TOTAL	191,336	4,966,563	5,157,899	3,448,940	10,573,813

*Consumer Durables Division Business and Defense Services Administration.
†Included in this figure are imports from Hong Kong in the amount of $104,672.

Fast Mould Repair

Repair chipped, cracked, or flawed cast iron moulds with Colmonoy No. 20

Fix the flaw with easily applied Colmonoy No. 20 oxy-acetylene rod. Blend the deposit into the surrounding surface by finishing it with a file. A little skill and very little alloy is all that's needed.

Colmonoy No. 20, a nickel, chrome, boron alloy is now available in a centerless-ground 1/8-inch diameter rod, as well as the familiar 3/16 and 1/4-inch diameter rods. Ask for Engineering Data Sheet E-36.

The use of spray-type brazing torches for mould repair work has recently gained favor. Colmonoy No. 21 powder was developed for this application method. Colmonoy No. 21 is similar to Colmonoy No. 20 and works exceedingly well. It may also be applied with the Colmonoy Spraywelder, with greater precision. Get Data Sheet E-30.

If you operate a glass container machine of any kind, you will benefit by using Colmonoy hard-surfacing alloys. Get the proof. Ask us for the Colmonoy Glass Industry Manual.

HARD-SURFACING & BRAZING ALLOYS

WALL COLMONOY CORPORATION

19345 JOHN R STREET • DETROIT 3, MICHIGAN

Buffalo • Chicago • Houston • Los Angeles • Morrisville • New York • Pittsburgh • Montreal • London, England

Circle No. 28

NEW BOOKS

INTRODUCTION TO CERAMICS. By W. D. Kingery, Associate Professor of Ceramics, Massachusetts Institute of Technology. John Wiley & Sons, New York. 781 pages. $15.00.

This book is concerned with ceramic products, rather than ceramic processing itself or the engineering aspects of production techniques. Instead of dealing with industry divisions and specialized small classes of materials, the volume is based on a rational approach to ceramic phenomena and properties. In this way, traditional ceramic compositions and recent space ages applications and functions of ceramics are placed in proper perspective for the materials science student and the practicing specialist.

All the standard ceramics included in separate discussions of glass, body formulation, electrical ceramics, refractories, abrasives, and glaze compositions have been brought in as illustrative material at points where science and technology dictate what these compositions are, rather than as separate branches of the industry. The book covers, in order of chapters, *(1)* ceramics today, *(2)* ceramic raw materials, *(3)* characteristics of ceramic solids, *(4)* development of microstructure in ceramics, and *(5)* properties of ceramics.

THE MILLION DOLLAR BEND. By Dr. Charles Eisler, Eisler Engineering Co., Inc. William-Frederick Press, New York (1960). 306 pages. $4.75.

An interestingly written autobiography of a young Hungarian boy who, with a natural inventive genius, came to America in 1904 and later founded the company that has borne his name for 40 years. Interwoven with a lively account of his personal and business hurdles is a discussion of Dr. Eisler's long list of inventions which contributed greatly to the progress of the radio and lamp industry. Of particular interest to the technician and student of the field is an extensive appendix liberally illustrated with photographs and drawings of many of his early machines, some of which are still in use today.

GLASS-TO-METAL SEALS. By Dr. J. H. Partridge, with a foreword by Professor Emeritus W. E. S. Turner. Published by the Society of Glass Technology, Sheffield, England. 238 pages. $7.00.

This book was first published in 1949 and has been out of print for a number of years. Because of the continued demand, the society has reprinted this volume, and it is again available. Already well-known to those in the field, this standard reference work contains information on *(1)* types of glass-to-metal seals, *(2)* the properties of metals suitable for glass-to-metal seals, *(3)* the preparation of metals used for sealing to glass, *(4)* glasses used for sealing to metals, *(5)* seals made by direct fusion of glass to metal, *(6)* seals made with the aid of intermediate metals, *(7)* glass-to-metal seals made by mechanical methods, *(8)* the practical methods employed for fusing glass and metal, *(9)* strain in glass-to-metal seals, *(10)* the effect of heat treatment on strain in glass-to-metal seals, *(11)* the evaluation of the principal stresses in a glass-to-metal seal, *(12)* the adhesion of glass to metal, and *(13)* glass-to-glass, glass-to-ceramic, and ceramic-to-metal seals, in that order.

CONTAINER GLASS COMPOSITIONS

(Continued from page 629)

spathic sands as the source of silica, the alumina being established by its proportion in the sand. The higher potash values for the West Coast glasses are due also to the use of these sands. Compared with the average composition for 1957, the 1960 West Coast glasses showed a decrease in both alumina and potash contents, indicating an increase in the use of "pure" silica sand which has become available in recent years. The presence of B_2O_3 in many of the West Coast glasses results from the use of soda ash containing a small percentage of borax.

The chemical differences among the three areas are great enough to result in three significantly different average compositions. As shown in Table VIII, differences among values for physical properties also exist. The coefficient of thermal expansion is least for the Northeast area and greatest for the West Coast area. The temperatures for selected viscosities are different for the three areas. This results in the decrease of relative gob temperature and working range index and the increase of the relative machine speed as one goes from the Northeast to the West Coast. Compared with the 1957 data, the West Coast glasses showed a slight but significant increase in relative machine speed, and continued to be substantially higher than the other areas.

AMBER CONTAINER GLASSES—NORTHEAST AREA ONLY

In the Northeast area of the United States, a large percentage of the amber-colored container glasses are produced from batches containing metallurgical slag. A sufficient number of amber container samples (17) were available from this area to estimate the proportion of different types of glass compositions in use for production of amber containers.

In this group of glasses, 29 per cent were produced with calcite as the source of the RO group, 12 per cent used dolomite, and 59 per cent used calcia and magnesia in roughly a 78 to 22 proportion. Using the presence of manganese dioxide (MnO_2) as the indicator, slags were used in 47 per cent of the amber glasses.

The average compositions and averages of the physical properties for the entire group of amber glasses and for the three different RO groupings are given in Tables IX and X, page 662. The three groupings are sufficiently different chemically to result in different physical properties and different working characteristics. While other composition differences exist, the most significant difference is in the make-up of the RO group. These differences can be considered to be the replacement of calcia (CaO) by magnesia (MgO).

In the substitution series (calcite to dolomite), the influence of replacing calcia by magnesia results in a decrease in the coefficient of thermal expansion, and changes in the low-temperature viscosity relationships. The substitution of magnesia for lime results in an in-

IT'S NEW
FROM SELAS!

QUAL-O-RIMETER*
COMBUSTION INDICATOR

Here's real production help for a wide variety of critical glass manufacturing operations. Providing for accurate combustion-control, the QUAL-O-RIMETER indicates changes in flame characteristics caused by variations in gas fuel supply and air-gas mixture. This new Selas instrument detects and indicates changes as little as ± 5 Btu in fuel gas and ± 0.5% air in air/gas mixtures in seconds! What's more, changes in flame configuration are indicated just as quickly! By presampling air/gas mixtures to dropping, decorating and annealing lehrs, the QUAL-O-RIMETER permits proper adjustment of fuel/air ratios before production is adversely affected. For more details write for Bulletin Q-2.

SELAS CORPORATION OF AMERICA
149 Dreshertown Road, Dresher, Pa.
*T.M. Reg. Applied For

SELAS

HEAT AND FLUID PROCESSING ENGINEERS
DEVELOPMENT DESIGN CONSTRUCTION

Circle No. 29

SYMBOL OF SERVICE

TOLEDO

A New Trademark, But The Same Dependable Service, Advanced Designing And Engineering That We Have Provided To The Glass Industry Since 1918.

The Toledo Mould Company offers a complete service—from product design and development to skillfully finished moulds.

We have access to all types of standard and special materials. In many instances we have been instrumental in finding a better material for special jobs.

Designed, engineered and manufactured in a modernly equipped plant by skilled craftsmen, Toledo Moulds are your assurance of accuracy, uniformity and trouble-free production.

Why not discuss your products—or problems—with us? Undoubtedly we can be of service.

TOLEDO MOULD COMPANY

A Division of Thatcher Glass Mfg. Co., Inc.

1923 Clinton St. Area Code 419 244—3868 Toledo 7, Ohio

Card: Circle No. 30

TABLE IX—Northeast Area Amber Container Glasses—1960
(Average Chemical Composition)

	Average Percentages			
	All Types	Calcite Only	78 Per cent CaO, 22 Per cent MgO	Dolomite Only
SiO_2	71.7	72.2	71.2	72.6
Al_2O_3	2.2	2.3	2.3	1.9
$CaO + MgO + BaO + Mg.$	11.5	11.0	11.9	10.6
$Na_2O + K_2O$	14.5	14.4	14.5	14.8
S	0.035	0.04	0.03	0.045
F_2	0.13	0.12	0.12	0.18
Fe_2O_3	0.19	0.23	0.16	0.25

TABLE X—Northeast Area Amber Container Glasses—1960
(Average Values of Physical Properties)

	All Types	Calcite Only	78 Per cent CaO, 22 Per cent MgO	Dolomite Only
Density g/cc at 20°C	2.501	2.501	2.506	2.490
Coefficient of Thermal Expansion 0-300°C, X 10^{-7}	87.5	88.1	87.3	86.7
Softness Temperature (log viscosity = 7.65)	715°C	720°C	714°C	707°C
Annealing Point (log viscosity = 13.0)	539°C	549°C	537°C	523°C
Strain Point (log viscosity = 14.5)	497°C	508°C	494°C	479°C
Relative Gob Temperature (log viscosity = 3.0)	1209°C	1201°C	1210°C	1224°C
Working Range Index	176	171	177	184
Relative Machine Speed (per cent)	105	109	104	99

crease in relative gob temperature, an increase in working range index, and a decrease in relative machine speed.

These differences in physical properties and working characteristics, which are the result of minor differences in chemical composition, serve to illustrate the fact that a batch formula stated in pounds of sand, soda ash, feldspar, lime, etc., is of little value unless it is related to a definite chemical composition, and, even more important, to values for physical properties and working characteristics. The standard chemical composition so formulated must be within specified control limits if the desired values of physical properties are to be maintained within the control limits necessary for efficient glass-forming operations.

REFERENCES

[1] H. Moore and A. K. Lyle, "Container Glass Compositions, 1932-1946," The Glass Industry, *28*, (November, 1947), 563-566.
[2] A. K. Lyle and A. G. Allen, "Container Glass Compositions 1947," The Glass Industry, *29*, (September, 1948), 493-594.
[3] P. A. Webster and H. Moore, "Container Glass Compositions—1948," The Glass Industry, *30*, (December, 1949), 657-659.
[4] A. L. Bracken, Jr., and P. A. Webster, "Container Glass Compositions—1949," The Glass Industry, *31*, (December, 1950), 625-626.
[5] A. L. Bracken, Jr., "A Review of Container Glass Compositions, 1940-1950." The Glass Industry, *32*, (September, 1951), 449-453.
[6] W. R. Lester "A Review of Container Glass Compositions (1932-1957)," The Glass Industry, *39*, December, 1958), 637-641.
[7] A. K. Lyle, "Viscosity Data on Commercial Glasses," *Ind. and Eng. Chemistry*, *46*, (January, 1954), 166.
[8] A. K. Lyle, W. Horak, and D. E. Sharp, "The Effect of Alumina upon the Chemical Durability of Soda-Lime Glasses," *Jour. Amer. Ceram. Soc.*, *19*, (1936), 142-147.
[9] H. R. Lillie, "Re-evaluation of Glass Viscosities at Annealing and Strin Points," *Jour. Amer. Ceram. Soc.*, *37*, (1954), 111.

DIMENSIONAL ANALYSIS

(*Continued from page* 635)

useful results can be obtained in the study of the flow of glass in tanks if the thermal problem is separated from the fluid flow problem, since the requirements upon the properties of the fluid are then much easier to meet.

These results of dimensional analysis lead to two experimental problems. The first is to find fluids with temperature coefficients of density and viscosity similar to glasses of interest. More data on the thermal expansion of fluid glass is needed. The other experimental problem is to find at what viscosity and stirring rate the effects of glass inertia become significant so that the more restrictive conditions (where k, the kinematic viscosity ratio, and the other variables depend on the size factor s) must be observed for correct modeling of the flow.

At first, one might think that it would be sufficient to make the gradients of kinematic viscosity similar in the model to those existing in the full-sized unit. If this were the case, there would be no problem in selecting a fluid for models to study convective flow. Unfortunately it is not so. To illustrate this, consider a hypothetical model fluid with 0 (zero) coefficient of thermal expansion but with some finite temperature coefficient of viscosity. Given a large glass unit with known distribution of kinematic viscosity and showing convection currents because of density differences in its various parts, it would evidently be possible by setting up the proper temperatures in the various parts of the model to make the distribution of kinematic viscosity in the model similar to that in the large unit. However, because of the 0 (zero) coefficient of thermal expansion of the model fluid, its density would be the same at all points of the model and no convection would occur.

To obtain, by model experiments along the lines here suggested, the maximum amount of information about the behavior of glass in tanks and other units where convection is important, much more data than we now possess is needed about the temperature distribution in actual glass units. However, even without the detailed knowledge of temperatures in tanks, etc., which is desirable, much useful information may be obtained by careful experiments with suitable models. Temperature distributions in models are relatively easy to measure, and it should be possible to infer, by studying the flow of suitable model fluids with temperature distributions which are similar to those thought to exist in actual glass units, whether the supposed temperature distributions are consistent with surface currents observed in the glass, and further, to learn how to alter the temperature distribution to obtain optimum performance. Especially attractive is the possibility of studying, at relatively little cost, the probable effect of radical changes in tank design upon melting efficiency.

(*Continued on page* 664)

A Key Chemical for the glass industry since 1890
Wyandotte Soda Ash
If you're sitting pretty making fiberglass for use in chairs, boats, fabrics, toys and what not, you'll find Wyandotte a wonderful source of supply for soda ash. When buying soda ash, why not draw on our more than 70 years of experience in producing it, transporting it, and studying its use in glass.
WYANDOTTE CHEMICALS
MICHIGAN ALKALI DIVISION, WYANDOTTE, MICHIGAN
Founded by a Glassmaker to Serve the Glass Industry
Circle No. 31

DIMENSIONAL ANALYSIS

(*Continued from page* 663)

Possible Model Liquids

Preliminary calculations for two viscous liquids, Vistac No. 2 (a polyisobutylene) and Corn Syrup Code 14 (a glucose solution), show that both have a suitable kinematic viscosity at about room temperature to serve in full-sized models to represent hard borosilicate glass at 1300°C. Inconveniently, high temperatures are required with these liquids to represent lead and lime glasses at 1300°C, or to represent hard borosilicate glass in a quarter-scale model.

When variations in temperature from point to point in model and unit are considered, the Vistac No. 2 proves to have too "long" a working range, and Corn Syrup Code 14 too "short" a working range to represent the glasses accurately. That is, when the hot-spot temperature in the model is adjusted so that the density of the model liquid there has the same ratio to the density of the model liquid at a colder reference point as the ratio of glass densities at hot spot and reference point, the actual viscosity of Vistac No. 2 proves to be greater, by a factor of about 2, than the product of the Vistac No. 2 viscosity at the reference point times the ratio of glass viscosities at hot spot and reference point. On the other hand, when the Corn Syrup Code 14 is heated to have the proper density at a hot spot, its viscosity is smaller, by a factor of about 4, than the desired viscosity caluculated from the Corn Syrup viscosity at the reference point and the ratio of glass viscosities. The fact that these two viscous liquids deviate in opposite directions from the behavior desired in an ideal model fluid encourages one to hope that other viscous liquids can be found which will represent both the density and viscosity behavior of glasses sufficiently well in the temperature range of interest. More experimental data is needed on relationships between temperature and density and between temperature and viscosity both for different glass compositions and for different model liquids.

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, JULY 2, 1946, AND JUNE 11, 1960 (74 STAT. 208) SHOWING THE OWNERSHIP, MANAGEMENT AND CIRCULATION OF

THE GLASS INDUSTRY, published monthy at New York, New York, for October 1, 1961.

1. The names and addresses of the publisher, editor, and managing editor are: publisher, Vincent M. Rabuffo, 466 Lexington Avenue, New York 17, New York; editor, Frank S. Child, 55 West 42nd Street, New York 36, New York; managing editor, Patricia L. Conway, 55 West 42nd Street, New York 36, New York; business manager, none.

2. The owner is: The Reuben H. Donnelley Corporation, 466 Lexington Avenue, New York 17, New York; Dun & Bradstreet Incorporated, 99 Church Street, New York 8, New York; Charles Martin Clark, Jr., and Katherine Clark Taber, trustees, c/o Bankers Trust Company, P.O. Box 704 Church Street Station, New York 8, New York; Eddy & Company, c/o Bankers Trust Company, P.O. Box 706 Church Street Annex, New York 8, New York; (Rev.) C. Pardee Erdman c/o The Reuben H. Donnelley Corporation, Prudential Plaza, Suite 2500, Chicago, Illinois; Freer & Company, c/o Continental Illinois National Bank & Trust Company of Chicago, Chicago 90, Illinois; Genoy & Company, P.O. Box 49, Church Street Station, New York 15, New York; Mrs. Carol D. Gordon, Llewellyn Park, West Orange, New Jersey; Massachusetts Investors Growth Stock Fund, Incorporated, c/o State Street Bank & Trust Company, Corner State and Congress Streets, Boston, Massachusetts; Keith McHugh, Clarence J. Myers and Robert Townsend as voting trustees under voting trust agreement dated August 31, 1961, c/o Northern Trust Company, 50 South LaSalle Street, Chicago, Illinois; Douglas R. Nichols and Douglas R. Nichols, Jr., as trustees under last will and testament of Payson Stone Douglas, deceased, 80 Pine Street (8th floor), New York 5, New York; Safe & Company, 13 South Street, Baltimore 2, Maryland; Safe Deposit & Trust Company of Baltimore Trustee under last will and testament of Jane J. Cook, deceased, 13 South Street, Baltimore, Maryland; Sail & Company, c/o State Street Bank & Trust Company, Boston, Massachusetts; Saul & Company, c/o Fidelity Union Trust Company, Trust Department, Newark 1, New Jersey; Sigler & Company, c/o Central Hanover Bank & Trust Company, 70 Broadway, New York, New York; Vanek & Company, 55 Broad Street, New York 15, New York; Atwell & Company, 45-47 Wall Street, New York, New York.

3. The known bondholders, mortgagees and other security holders owning or holding 1 per cent or more of total amount of bonds mortgages, or other securities are: none.

4. Paragraphs 2 and 3 include in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: 2324.

(Signed)
Vincent M. Rabuffo, *publisher*

Sworn to and subscribed before me this 6th day of October, 1961.

Walter H. Fredericks
Notary Public, State of New York
No. 41-6391975
Qualified in Queens County
Commission Expires March 30, 1962

INVENTIONS AND INVENTORS

(*Continued from page* 655)

Device for Preparing a Fleece, Sliver, or Yarn, in Particular, of Glass. Patent No. 2,976,580. Filed July 16, 1953. Issued March 28, 1961. Two sheets of drawings; none reproduced. By Johann Christoph Riedel.

In this invention, the filaments, in an uninterrupted operation, are drawn by a rotating drum (primary bobbin) from melting off rods from melts issuing from nozzles. They are then dragged along by the drum, lifted (after short-lasting adhesion) enough for the continuous drawing, and thus detached from the drum periphery. The lifting and detaching of the filaments is effected by means of an air stream directed or blown against the direction of rotation of the drum (primary bobbin) over the periphery, permitting the filaments to be fed to further treatment in freely flying conditions. The freely flying filaments may then be collected in divided or undivided condition to form fleece either or yarn, then finally stopped.

The advantage here is that the silky filaments or staple fibers obtained are quite undamaged, are straightened and parallelized by the wind, and can be stopped as a well-ordered fleece or yarn. To form fleece, the filaments or fibers thus parallelized are then sucked onto a support sweeping past, and are collected and further processed by the latter. The application on a traveling support is carried out preferably by sucking the filaments or fibers floating in the wind onto a sieve-like support, which may be a tape or a drum.

There were three claims and the following references.

United States Patents

2,194,728, Von Reis, March 26, 1940; 2,460,899, Modigliani *et al.*, February 8, 1949, and 2,621,444, Schuller, December 16, 1952.

Foreign Patents

965,189, France, February 15, 1950; 605,000, Great Britain, July 14, 1948, and 628,145, Great Britain, August 23, 1949.

Furnaces

Water-Cooled Glass Stirrer. Patent No. 2,982,522. Filed June 5, 1957. Issued May 2, 1961. One sheet of drawings; not reproduced. Assigned to Owens-Illinois Glass Co. by Joseph C. Hamilton and Robert R. Rough.

Stirring devices made of refractory materials which will withstand the high temperatures of the molten glass have been found unsatisfactory and inadequate as a means for stirring the lower strata of glass in the channel to mix the glass. These refractory stirrers are limited as to the depth to which they can be used, particularly because of breakage due to the contact with feeder refractories. Attempts have been made to overcome this difficulty by making stirrers of metal of adequate strength. Such stirrers must be provided with means for circulating water or other cooling medium through to withstand the high temperature of the glass. Such a stirring device, substantially in the form of an inverted T, has been tried. This device is comprised of a vertical tubular stem which is rotated about its axis, and horizontal extensions or arms which rotate in a horizontal plane adjacent the floor of the forehearth. It has been discovered that such a stirrer causes undue chilling and freezing of the glass near the center of the stirring zone because the glass in this region is comparatively stagnant and in close proximity to the cooled stirring device.

A primary object of the present invention is to overcome this difficulty. For this purpose the invention provides a stirrer comprised of a vertical tubular body with arms extending downward and outward or branching sections. These stirring arms reach downward into the lower strata of glass, and operate to produce a strong movement of the glass substantially at right angles to the general direction of flow through the channel and transverse to the cords in the flowing glass. The central portion of the stirrer is spaced sufficiently above the channel floor to prevent objectionable cooling.

One claim and ten references.

CLASSIFIED ADVERTISEMENTS

Help Wanted

MANAGER OR ASSISTANT MANAGER: for engineering sales and development of activities listed in our ad this issue plus other new developments. Degree and considerable experience glass industry required. Must have organizing ability and managerial interest. Limited travel USA and abroad. Reply to Penberthy Electromelt Company, 4301 6th Ave. South, Seattle 8, Washington.

PEN ELECTRO Service to the Glass Industry

- Electric Booster Melting
- Molybdenum Electrodes
- Tubing Diameter Gagers
- Glass Bath Pyrometers
- All Electric Furnaces
- Electric Forehearths
- Bubbler Systems
- Color Feeders

Write for descriptive literature

PENBERTHY ELECTROMELT CO.
4301 6th AVE. SOUTH
SEATTLE 8, WASHINGTON

THE SHARP-SCHURTZ COMPANY

CHEMISTS AND CONSULTING ENGINEERS FOR THE GLASS INDUSTRY

LANCASTER, OHIO U. S. A.

Circle No. 32

EISLER Equipment
solves glass problems!

Since 1920, designers and builders of special machinery and equipment for the glass industry . . .
Glass Lathes • Glass Cutters • Wet or Dry Silent Blast Torches • Cross Fires • Ribbon Fires • Gas and Oxygen Burners • Indexing Turntables • Sealing, Ampule and Bulb Blowing Machines, etc.
Call us now without obligation

Above: SPECIAL CROSSFIRES
Below: BLAST BURNERS

EISLER ENGINEERING CO., INC.
742 So. 13TH ST., NEWARK 3, N. J.
Charles Eisler, Jr.
President
Circle No. 33

Delos M. Palmer & Associates

Consulting Engineers
Mechanical, Electrical & Industrial
Designers of
Special Purpose Machinery
For The Glass Industry
Automation . . . Electronics

4401 JACKMAN ROAD TOLEDO 12, OHIO
Telephone: Greenwood 9-4453
Circle No. 34

EXPERT HANDLING
Mathieson Soda Ash – Use Olin Mathieson know-how and technical assistance to become expert in handling soda ash. A detailed study of your facilities will be made on request. Send for our free Soda Ash book now. Write today to OLIN MATHIESON, Baltimore 3, Maryland.
8958
Rail, truck and barge shipments from Saltville, Va., Lake Charles, La., and Wyandotte, Michigan.
CHEMICALS DIVISION
Olin

Circle No. 35

The Ganaglass Automatic BATCH CHARGER
The GANAGLASS automatic batch charger was developed to fill a definite need in the modern glass industry for an automatic batch charger that would incorporate the following:
• IMPROVED PRODUCT QUALITY
• LOW PURCHASE PRICE
• LOWER GLASS MELTING COST
• RUGGEDLY BUILT
• EASY INSTALLATION
• PROLONGED FURNACE LIFE
• ECONOMICAL OPERATION
• SIMPLE ADJUSTMENTS
We welcome the opportunity of submitting full details.
GENERAL GLASS EQUIPMENT CO. INC.
INTERNATIONAL, INC.
ATLANTIC CITY, NEW JERSEY

Circle No. 36

INDEX TO ADVERTISERS

	Page
Adams Company, Inc., R. P.	613
Air Preheater Corporation	621
American Potash and Chemical Corporation	615
Ateliers de Construction de la Meuse, S. A.	608
Cambridge Wire Cloth Company, The	640
Classified	665
Colorado Fuel and Iron Corporation Wickwire Steel and Fuel Division	643
Corhart Refractories Company	605
Diamond Alkali Company	620
Drakenfeld and Company, Inc., B. F.	617
Eisler Engineering Company, Inc.	665
Ferro Corporation	611
Food Machinery and Chemical Corporation Chlor-Alkali Division	645
Frazier-Simplex, Inc.	603
General Glass Equipment Company	666
Harbison-CarborundumCorporation	Cover IV
Harbison-Walker Refractories Company	619
Harshaw Chemical Company, The	622
Hooker Chemical Corporation	612
Kaiser Aluminum and Chemical Corporation	609
Kirk and Blum Manufacturing Company, The	Cover II
Minneapolis-Honeywell Regulator Company	607
Olin Mathieson Chemical Corporation	666
Overmyer Mould Company, Inc.	614
Palmer, Delos M.	665
Penberthy Electromelt Company	665
Radiation Electronics Company Division of Comptometer Corporation	616
Selas Corporation of America	661
Sharp-Schurtz Company	665
Surface Combustion Corporation	618
Taylor Sons Company, Chas., The	Cover III
Titanium Pigment Corporation	606
Toledo Engineering Company, Inc.	656
Toledo Mould Company, The	662
Wall Colmonoy Corporation	660
Walsh Refractories Corporation	647
West End Chemical Company	610
Wyandotte Chemicals Corporation	663